THE
ELECTRICAL REVIEW.

VOL. L. JANUARY 10, 1902. No. 1,259.

CONTENTS:

	PAGE
A Hard Case ...	41
Trade Names ...	42
Electric Feed Pumps (*illustrated*) ...	43
Sparkless Commutation with Fixed Brushes (*illustrated*)	44
The Profitable Sale of Electricity ...	47
Caldwell's Röntgen Ray Stereoscope (*illustrated*)	48
Distribution Cables for Three-Phase Working (*illustrated*)	50
The Transformation of the Underground Railway.—II.	51
Correspondence:—	
Towns and their Systems of Electricity Supply	52
The Testing and Management of Electric Motors	52
Overhead *v.* Underground Wires	52
The Carriage of Goods by Tram and their Delivery	52
Electric Car Equipments and their Maintenance	52
The Tramway Junction at Sheffield	53
Fire Insurance	53
Business Notes	54
Portsmouth Electric Tramways (*illustrated*)	59
Supply Station Accounts	69
Traffic Receipts	70
Stocks and Shares	70
Share List of Electrical Companies	71
Market Quotations	72
Applications and Uses of Arc Lamps (*illustrated*)	73
Note on Alternate Current Diagrams	74
The Destructive and Lethal Effects of High Pressure Currents (*continued*)	75
The Aquarium Exhibition	76
Current Specifications.—LXXXVII.	77
High Speed Steam Engines	77
New Patents	79
Abstracts of Published Specifications	80

THE
UNIVERSAL ELECTRICAL DIRECTORY

1902 Edition

NOW IN PREPARATION.

NEW MATTER AND CORRECTIONS SHOULD BE SENT IN AT ONCE.

H. ALABASTER, GATEHOUSE & CO.,
4, Ludgate Hill, London, E.C.

THE ELECTRICAL REVIEW.

Published every FRIDAY, Price 4d.

The Oldest Weekly Electrical Paper. Established 1872.

TO BE OBTAINED BY ORDER FROM ANY NEWSAGENT IN TOWN OR COUNTRY.

OFFICE:—4, LUDGATE HILL, LONDON, E.C.

Telegraphic Address: "AGEEKAY, LONDON." Code, A B C.
Telephone No. 933 Holborn.

ALL Letters should be addressed to the Proprietors, H. Alabaster, Gatehouse & Co.

ADVERTISEMENT RATES ON APPLICATION.

The "Electrical Review" is the recognised medium of the Electrical Trades, AND HAS

BY FAR THE LARGEST CIRCULATION
of any Electrical Industrial Paper in Great Britain.

SUBSCRIPTION RATES.—In Great Britain, Post Free per Year, 19s. 6d. To all other countries, per Year, £1 10s.

BINDING.—Subscribers' numbers bound, including case, for 4s. each volume.

CASES.—Cloth Cases for Binding can be had, price 2s. 6d. each.

READING CASES, to hold from One to Twenty-six Numbers until the volume is complete for Binding, can now be had from the Publishers, Price 6s., or Free by Post (in Great Britain), 6s. 6d.

FOREIGN AGENTS.—New York: D. VAN NOSTRAND, 23, Murray Street. Paris: VEUVE J. BOYVEAU, 22, Rue de la Banque. Berlin: ASHER & Co., 13 Unter den Linden.

Cheques and Postal Orders (on Chief Office, London), to be made payable to Mr. H. ALABASTER, 4, Ludgate Hill, E.C.

A HARD CASE.

IN our issue of December 20th, 1901, we published a report of the case of Izaacson *v.* New Grand Theatre of Varieties, which was heard before Mr. Deputy Judge Horton Smith, K.C., and a jury at the Westminster County Court on Monday, December 16th. In these days of almost universal compensation for injuries sustained by workmen in the course of their employment, it seems a little hard that artisans of exceptional skill should be deprived of the protection afforded to their weaker brethren. The material facts of the case were shortly these: The plaintiffs sought to recover damages under the Employers' Liability Act, 1880, and Lord Campbell's Act, 1846, for the death of their son, S. V. Lee Izaacson, who was killed by scalding in a "sump" close to the engine used for working the electric lighting plant at the defendants' theatre. The accident seems to have happened owing to the absence of a lid to the "sump," which was full of scalding water. The deceased was 23 years of age, and had won several scholarships and many medals for pro ficiency in various branches of electricity and chemistry. He was earning wages (including overtime) to the extent of £3 12s. a week. The defence raised the following points:—(1) That the deceased was not a workman within the Employers' Liability Act, 1881; (2) that there was no negligence on the part of anyone in charge. At the conclusion of the arguments, the learned Judge said:—"It was not part of the deceased's duty to do what he was doing. If I had done it, it would not make me a workman. His duties were to superintend in the absence of some other man. There is no case to go to the jury, as I hold that the deceased was not a workman." Subsequently, the plaintiffs' counsel, failing to obtain relief for his clients under the older Acts, made application to the Court under the Workmen's Compensation Act, 1897. As is well known, that Act only applies to employment on, in, or about a "factory," &c. The defendants at once raised the point that an electrical generating station was not a factory. A factory inspector who was called as a witness, said that, in his view, such places were factories, and that they were so regarded at the Home Office. The learned Judge, however, once more ruled against the plaintiffs on this point, saying, "I have friends in the country who have their own electrical plant, but their houses are not factories. Electricity is only generated at this theatre for the defendants themselves."

To deal in the first place with the ruling of the learned Judge that Izaacson was not a workman, it is necessary to refer to some of the authorities on the subject. The expression "workman," to which the Employers' Liability Act applies, includes any person who, being a labourer . . . . journeyman, artificer, handicraftsman . . . or otherwise engaged in manual labour . . . . has entered into or works under a contract with an employer. If Izaacson had been within this definition, his relatives would have been entitled

to compensation under the Act of 1881, always assuming that there was negligence on the part of the employers.

The test whether a man is engaged in manual labour is whether the workman who does work with his own hands in performance of his contract was absolutely bound by the terms of his contract so to do. [Ingram *v.* Barnes, 7 E. & B. 115.]

According to the facts set out in our report, the deceased was bound to attend to the engine and boiler in the absence of another man. How then can it be said that he was not engaged in manual labour? But even assuming that he was not so engaged, it is hardly possible to think that the learned Judge was right in holding that he was not an artificer, having regard to the judicial interpretation put upon that term. "I cannot conceive," said Mr. Justice Williams, in the case of *ex parte* Ormrod (1 Dow. & E., 825), "that the word artificer only applies to persons engaged in such occupations as require merely manual labour." In the case then before his Lordship the term was applied to a designer of patterns for a calico printer, and in a later case it was applied to an overseer in a printing office (Bowers *v.* Lovekin, 25 L.J.Q.B., 371).

In view of these authorities, we would respectfully submit that the learned Judge was wrong in holding that an experienced electrical fitter is not a workman, and that upon that ground he is not entitled to the relief granted to other workmen by the Employers' Liability Act. To deprive a man of compensation merely because he happens to be a *talented* handicraftsman, would seem to be contrary to the first principles of justice.

On the other point, namely, whether the man was employed in a "factory" within the meaning of the Workmen's Compensation Act, 1897, we venture to agree with the finding of the learned Judge. The term "factory" as used in the Workmen's Compensation Act has the meaning given to it in the Factory Acts. For some reason or other, generating stations and electric lighting installations were excluded from the operation of those Acts until the present year, when the definition of the word factory was extended by Schedule VI. (20) of the new Factory and Workshop Act, to electrical stations, *i.e.*, any premises or that part of any premises in which electrical energy is generated or transformed for the purpose of supply by way of trade, or for the lighting of any street, public place, or public building, or of any hotel, or of any railway, mine, or other industrial undertaking." This Act did not come into operation until January 1st, 1902, so that it could not assist the plaintiffs in the present action, but even if it had been in force at the time when the accident happened, it is somewhat doubtful whether a private installation used for lighting a theatre could come within the definition.

TRADE NAMES.

From recent issues of the American journals it appears that a decision of some importance to firms in this country has lately been given in the United States Circuit Court for the northern district of California, in an action by the Babcock & Wilcox Company against the Joshua Hendy Machine Works. Particulars of the case are not yet given, but we can gather their nature from the terms of the decision. The action has evidently been brought to restrain the defendants from selling boilers as "Babcock & Wilcox" boilers, and a perpetual injunction has been granted enjoining the defendants, their servants or agents, "from using the name 'Babcock & Wilcox,' either alone or combined with other word or words upon or in connection with the sale or offering for sale, of any boiler or other steam apparatus not manufactured by the complainant, and from stating or representing that any boiler or other steam apparatus sold or dealt in by the respondent and not manufactured by the complainant, is a Babcock & Wilcox boiler, and from selling or offering for sale or passing off any such boiler or other steam apparatus, as and for boilers or steam apparatus manufactured and sold by the complainant."

The particulars of this case should be interesting, for, judging from what we now learn of it, it looks as if one of the most interesting points in the law of "trade names" has been raised. To make the point clear, we will refer first to the ordinary action brought by one person against another for "passing off" his goods as those of plaintiff. That action may be based on an actual fraudulent "passing off," but more usually the ground of complaint is that the defendant has—it may be, innocently—copied some word or symbol used by the plaintiff in connection with his goods. The Courts have clearly laid down the principle that no person must use a name, whether real or fictitious, which is calculated to represent to the world that his manufactures are in reality manufactured by another, and so deprive that other of the profits due to him (Levy *v.* Walker, 10, Chancery Division (1879), p. 447). A good example of the application of this principle is given in the case of Wotherspoon *v.* Currie (Law Reports, 5 House of Lords, p. 508). The plaintiffs in that case were manufacturers of starch, to which they had given the name "Glenfield," and Glenfield starch had acquired a high reputation. The defendant went to Glenfield and there began to manufacture starch; but the House of Lords held that the word "Glenfield" had a secondary meaning in connection with starch manufacture, that it had really come to denote starch of the plaintiffs' manufacture, and that the fact that the defendant was really making starch at Glenfield did not exempt him from the consequence of the fact that his proceedings were intended and calculated to produce on the mind of the public the belief that his article was the article made by plaintiffs. An even more striking case was that commonly known as the "Camel-Hair Belting" case (Reddaway *v.* Banham, 1896, 13 Rep. Patent Cases, p. 228). Here the plaintiff manufactured belting, to which he gave the name Camel-Hair Belting, and by this name it became known to the public. The defendant, at a later period, began to manufacture belting from the yarn made from camel-hair, and put it on the markets as "camel-hair belting." The Courts, however, granted an injunction, in spite of the fact that this name was merely descriptive of the material from which the belts were made; for it was shown that the name "camel-hair belting" had come to have the meaning "belting made by the plaintiff" and not merely "belting made from camel-hair." In such cases, however, where some descriptive word is used, the plaintiff must always prove that the word has lost its original meaning and has come to denote to persons in the trade goods manufactured by the plaintiff.

These cases make the general principle perfectly clear, but the true difficulty arises when we come to names which have been applied to patented articles. Suppose that an inventor has patented some article and, in putting it on the market, has given it a name which he himself uses as a trade name, and the article becomes known by that name. So long as the patent is in force, he has the monopoly of manufacture; but when the patent expires, has he a right to prevent other people from selling the article under that name? It is perfectly clear that if he has that right, then the result is equivalent to giving the inventor a perpetual monopoly of manufacture, instead of only for 14 years; for if he alone can use that name, and the article is known by no other name, the general public cannot profit from the expiry of the letters patent. This case has been raised on several occasions before the British Courts, and we suspect that the point in the American case with which we opened, may have been somewhat similar. The best known English case is the "Linoleum Case" (Linoleum Company *v.* Nairn, 7 Chan. Div., p. 834). There the Court found that the name "Linoleum" had come to mean the patented article, and not goods of plaintiff's manufacture, so that, as the patent had expired, the Court refused to restrain the defendant from making and selling "linoleum floor-cloth." This case was followed in the present year in the matter of the Cheseborough Manufacturing Company's trade marks (18 Rep. Patent Cases, p. 191), where an application was successfully made to have the word "Vaseline" struck off the register of trade marks, on the ground that at the date of its registration (1877) it was the name of a patented article (petroleum jelly) and not descriptive of goods of the Cheseborough Company.

These are cases in which the Courts have prevented inventors from retaining the exclusive use of the name of their patented article, after the patent has expired, but the most interesting case arises when the patented article is not given a descriptive or fancy name, but becomes known by the name of its manufacturers. Thus, let us suppose there is an engineering company trading as "The A and B Company," and suppose that that company obtains a patent for (say) a motor, which is put on the market as the "A and B motor," and achieves a wide reputation. So long as the patent is in force, the A and B Company are, of course, sole makers, but when the patent expires the manufacture of this motor is open to the world. Can a rival firm begin to advertise that they are selling "A and B motors"? It must be noticed here that the name "A and B" is not simply the name of patentees; it is the name of a firm of engineers who are known to the world as makers of (among other things) motors. Obviously, therefore, the offer of "A and B motors" might appear to the public as an offer of motors made by the A and B Company, and not merely motors of the type for which the patent has expired; and whenever it can be shown that the name indicates goods manufactured by the firm of that name, the Courts will restrain others from using it, even though their use be solely to describe a particular article, for which the firm of the name in question formerly held a patent. This may prove to be the point raised in the Babcock & Wilcox American case, viz., the question whether that name denoted the manufacturers or merely a type of boiler, and, if so, the decision conforms to what we have said above.

ELECTRIC FEED PUMPS.

By A. JOHNSTON.

THE uneconomical results obtained in practice from steam boiler feed pumps are, to a great extent, responsible for the employment of electrically-driven feed pumps where the steam plant is utilised, to some extent, for generating electricity; it cannot be denied, however, that electric motors are not well adapted to drive feed pumps, the great ease with which steam feed pumps can be regulated to deliver any desired quantity of water to the boilers giving them an advantage that cannot be overlooked in practice.

It is generally necessary to instal a feed pump capable of supplying a much greater quantity of water than the average amount required, as it must be possible to gain on the water in the boiler in case it should at any time be allowed to get below the working level; thus the feed pump

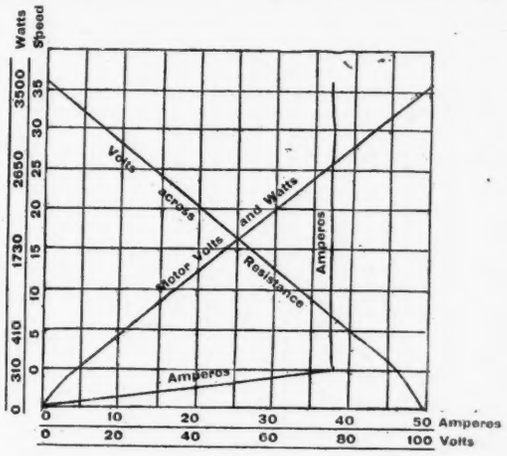


FIG. 1.

can seldom be run at full load. One method of reducing the quantity of water delivered to the boiler by an electric feed pump is by closing, or partially closing, the check valves, in which case the feed pump is run at a constant speed, and must be fitted with a relief valve set to open at 20 or 25 per cent. above the working pressure of the boiler, which will allow the surplus water pumped to return to the water tank

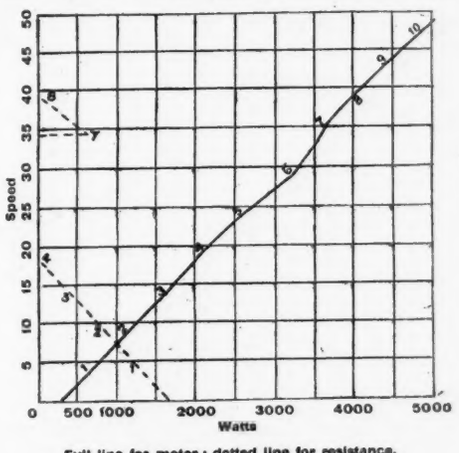


FIG. 2.

or hot well. Another arrangement adopted to gain the same end is by inserting resistance in series with the motor, and thus reducing its speed, but this, of course, means a constant loss of power in the resistance. When the regulation is done by the boiler check valves, the motor must be powerful enough to drive the pump against the pressure required to open the relief valve and will be run fully loaded, except occasionally when the full amount of water delivered by the pump is allowed to enter the boiler, the load then being reduced according to the difference between the pressure to which the relief valve is set and boiler pressure.

D

The second method of regulating the amount of water referred to is more general, but is only slightly more economical than the first. It is clear that the amount of water pumped, and therefore the power required to drive the pump, will vary in direct proportion to the speed, and that if the field strength is kept constant the speed of the motor will vary with the voltage across its terminals; further, as power taken by the motor (C × V) is in proportion to the speed, and the voltage (V) is also in proportion to the speed, the current (C) will be constant at all speeds. The external resistance performs the duty of reducing the voltage across the motor terminals; the power it wastes, together with the power taken by the motor, will be constant at all speeds, as the current passing through both is constant, and for any quantity of water Q delivered by the pump, expressed as a fraction of the full amount it is capable of delivering, the proportion between the wasted power and the power used will be—

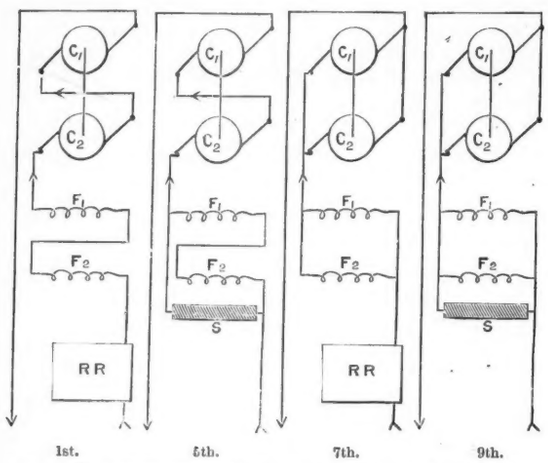
$$1 - Q : Q$$

Fig. 1 shows, from a test, the power taken by a series-wound motor driving a three-throw feed pump, and its regulating resistance; it will be seen that the current is almost constant at all speeds. The watts required by any motor to drive a single-acting pump can be found approximately by the formula :—

$$W = K r l n d^2 \left(P - \frac{3h}{7}\right),$$

Where K = ·0015, a constant.
r = revolutions per minute of pump.
l = length of pump stroke, in inches.
n = number of cylinders in pump.
d = diameter of pistons or plungers of pump, in inches.
P = pressure (above atmosphere) at the pump delivery valves, in lbs. per square inch.
h = head of water, in feet, at suction side.

If there is no head of water, but, instead, the water is drawn from below the pump, h becomes a negative quantity representing the distance, in feet, the level of the water is below the level of the pump. If the pump is double-acting, l must be multiplied by 2.



C1, C2, The two armature windings; F1, F2, The two sections of field coils; RR, Regulating resistance; S, Shunt of field.

Fig. 3.

Allowance must be made for the power lost in the motor, pump, and gearing, which may be from 15 to 40 per cent., according to the arrangements adopted.

It is an advantage if the motor is designed to run at the average speed required, without the introduction of external resistance, its speed being increased, when necessary, by weakening the field; this cannot be carried beyond a certain limit, owing to the weakened field being distorted badly, thus causing great sparking at the brushes if over done.

A further advantage is gained by series-parallel control of the motor, which gives it a fairly wide range without external resistance. Of course, no complicated switch gear should come under the care of the firemen; a simple hand-wheel or handle which, when turned in one direction, increases the pump's speed while the other direction reduces it, and which is so constructed that it cannot be turned too quickly, should be used. To adopt the series-parallel control the motor armature must have two separate and similar windings, each connected to a separate commutator; the field may be excited by a shunt current or the armature current, the latter being preferable, as the motor will have greater torque when running up to speed, but in this case the field coils must be divided into two sections with an equal number of coils in series in each, the motor, therefore, must have an even number of coils. The following is a list of the combinations made by the controller at each position or notch :—

1st Position = The two armature windings, the two sections of field coils and the regulating resistance all in series.
2nd „ = As 1st, but with one-third of the regulating resistance cut out.
3rd „ = As 1st, but with two-thirds of the regulating resistance cut out.
4th „ = As 1st, but with all the regulating resistance cut out.
5th „ = As 4th, but with some of the field current shunted.
6th „ = As 5th, but with additional field current shunted.
7th „ = The two armature windings in parallel, in series with the two sections of field coils in parallel, in series with one-sixth of the regulating resistance.
8th „ = As 7th, but with all regulating resistance cut out.
9th „ = As 8th, but with some of the field current shunted.
10th „ = As 9th, but with additional field current shunted.

Additional notches could be put between the 1st and 4th, the 4th and 7th, and the 8th and 10th if desired, to make the adjustment finer. Fig. 2 shows the power taken and speed curve of a motor controlled as described, and fig. 3 shows the connections for the 1st, 5th, 7th and 9th positions.

The capacity of the pumps has been assumed here as double the average quantity of water required; this should be ample, though it is more or less contrary to general practice, engineers usually consoling themselves by thinking that having a pump too large is a good fault, but it is a fault which has a detrimental effect on the economy of the pump. Worm gearing is silent and works well while new, but it is a great wearing agent and absorbent of power. Gear wheels and pinions also absorb power, and are noisy and troublesome. There seems to be nothing to prevent the motor being direct coupled to the pump; it will, of course, be larger and more expensive than a motor running at 3,000 or 4,000 revolutions per minute and driving the pump by belts and gearing, but the pump will be smaller and less costly. High speed feed pumps are quite within the bounds of possibility, though makers prefer to stick to the beaten track.

SPARKLESS COMMUTATION WITH FIXED BRUSHES.

By CLAUDE W. HILL.

One of the principal factors in determining the prime cost and weight of dynamos is the amount of power which has to be expended in the air-gap in order to ensure sparkless collection.

If we examine machines by different makers, of similar type, and constructed for the same output, speed, temperature, and efficiency, we find remarkable variations in weight, and if we look more closely into the several designs we find that the variation exists almost entirely in the magnets, and is due to the different amounts of excitation which the different makers find necessary to give satisfactory commutation.

In this article the writer proposes, first, to review the method of calculation which gave satisfactory results with the older forms of machine having copper brushes, which required to be moved for each change of load, and then to indicate the modification necessary to obtain satisfactory working with fixed carbon brushes and minimum gap excitation, by which means a minimum weight of machine may be obtained.

Let us (although it is an old story) as briefly as possible consider what happens during the process of commutation.

In fig. 1 are represented diagrammatically the short-circuited coil, the commutator bars and the brush.

We will assume that the armature and commutator are standing still, and that a current of 200 amperes is being passed into them through the brush. When the edge of the brush is just about to touch bar B the current in the coil C is 100 amperes flowing from left to right. If now we advance the brush a little way on to bar B, a direct path is provided past coil C, but as the contact resistance of the brush on bar B is higher than on bar A, a portion of the

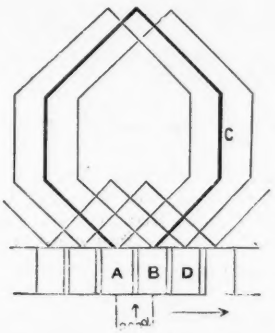


Fig. 1.

current will still pass through C. As we move the brush to fresh positions in the direction of the arrow the contact resistance on B diminishes while on A it increases, and the current in C falls until the brush is exactly central over A and B when it becomes zero. As the brush is moved further along the contact resistance on A continues to increase and on B to diminish, and so current commences to flow in C in the opposite direction, that is, from right to left, until it reaches 100 amperes just as the back edge of the brush leaves bar A. If instead of placing the brush in successive positions we move it along slowly, the current in each coil, as it is short-circuited, will fall from 100 amperes, at the point where the brush first enters the bar B, to zero as the brush passes the central position, and will rise to 100 amperes in the opposite direction as the brush leaves the bar A. And these changes, provided the motion of the brush is slow, will take place

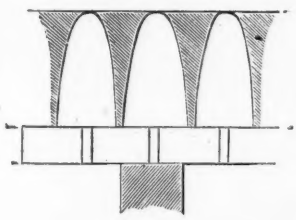


Fig. 2.

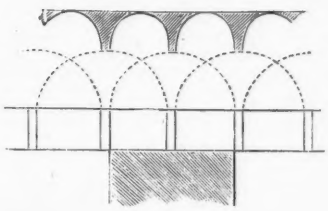


Fig. 3.

without any sparking, as at the moment of changing from bar to bar the current in adjacent coils is of identical value.

If, however, we move the brush with sufficient rapidity the current in the short-circuited coil in undergoing its change of direction will set up an E.M.F. of self-induction which will disturb the flow of the current so that at the moment of changing from bar to bar the current in adjacent coils will not be of the same value. At this point there will then be a sudden change in the value of the current which will give rise to sparking.

The value of this self-induced E.M.F. or reactance voltage is given by formula No. 1, provided we assume that the reversal of current follows a sine curve,

$$r = \frac{\pi N_1 m_1}{s} \times 10^{-8}, \qquad (1)$$

in which r = the reactance voltage, N_1 = the flux due to the ampere-turns in the short-circuited coils, m_1 = the number of turns in one coil, and s = the time in seconds during which the change of current takes place, which again is equal to half a complete cycle. When the brush is central over bar B, and in contact with A and D, two coils are short-circuited, but as their contact resistances are out of balance current is flowing in both of them, which must also be the case to satisfy the assumption of a sine curve which we have taken in formula No. 1. The author mentions this as it is not unusual to take in calculating r the maximum number of coils short-circuited and to assume that their currents pass through zero at the same instant, an assumption which gives us a value of r somewhat higher than the true value.

For a reason which can be best explained by the aid of diagrams, it is advisable to let the brush short-circuit several coils simultaneously instead of only one at a time. The rate

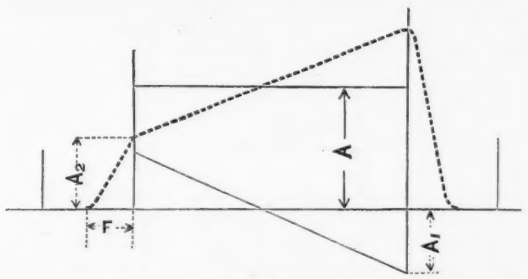


Fig. 5.

of change of N_1 is shown in diagram, fig. 2. The reversing field which projects from the pole tip is a constant quantity, and so there is a resultant field, shown shaded, which is at its maximum at the beginning and end of commutation, and tends to set up sparks. Figs. 3 and 4 show how the resultant field is modified and reduced when two and three coils are short-circuited respectively.

To obtain sparkless collection then, we must, with copper brushes, eliminate r, or with carbon brushes, reduce it to such an amount as will give sparkless collection.

In the older class of lighting dynamos which were still being made until quite recently, the use of copper brushes compelled us to practically eliminate r, and the conditions of working enabled us to do so.

Under these conditions the loads on the machines were principally lighting loads and varied gradually. The

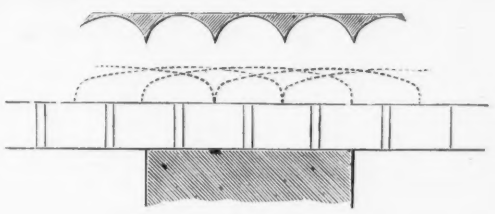


Fig. 4.

machines were fitted with brush rockers which enabled the brushes to be adjusted to the non-sparking position for each change of load, and the machines having smooth cored armatures had long air-gaps, so that there was no difficulty in getting strong reversing fields even with two-pole machines of considerable size.

To eliminate r we must impress upon the coil which is undergoing commutation a magnetic flux N_2 equal in amount and opposite in direction to N_1. Such a flux can be found in the fringe extending from the pole tip, provided that the excitation in the gap exceeds by a sufficient amount that necessary to neutralise the reaction of the armature and also to neutralise the field due to the current in that portion of the armature winding which is in the interpolar space.

N_1, however, varies with variation of load, so that with each change of load it is necessary to shift the brushes to obtain the corresponding value of N_2. If the brushes are not in the correct position a reactance voltage due to $N_1 - N_2$ will be set up, and this will be proportional to the number of turns per section, so that in standard carcases wound for

the same output but different voltages, an error of brush position which only gives a trifling spark in a 100-volt machine will cause a considerable one in a machine of, say, 400 volts, because, although $N_1 - N_2$ remains constant, there are four times the turns per section, so necessitating greater attention to the brushes.

In fig. 5, the heavy dotted line shows approximately the distribution of the field when the armature is loaded. The magnetic fringe within which the correct value of N_2 must be found is shown at F. In order to keep down the demagnetising back turns of the armature it is advisable to work with a small lead of brush, and it is evident from the diagram that the higher the value of A_2 the less is the amount of lead required to obtain the requisite value of N_2. At the same time a high value of A_2 means an expensive machine, and so we must decide upon a value which, while giving us sparkless collection with reasonable brush movement, will not make the machine unduly costly.

Formula No. 1 may be conveniently expanded into formula No. 2, in which the items which go to make up r are given in detail,

$$r = \frac{\cdot 1645 \times D\,R\,f\,l\,c\,m\,m_1}{t} \times 10^{-8}, \qquad (2)$$

in which D = diameter of commutator in inches, R = revolutions per minute, f = C.G.S. lines per inch length of armature induced by one ampere turn, l = length of armature in inches, m = the number of magnetising turns in the portion of the armature undergoing commutation, and which depend on the number of bars covered by the brush, m_1 = the number of turns per section of the armature, and t = thickness of the brush in inches.

We can see from this formula that the only item the effect of which can be varied when the machine is working is $c\,m$ ($= A_3$) the magnetising ampere-turns. Their effect may be entirely neutralised by the imposition of a field having an equal and opposite value (expressed in ampere-turns). Thus r becomes zero, and the remaining items may be disregarded, so that so long as we can adjust the brushes, sparkless collection is independent of the speed and length of armature. What is necessary, then, is that A_2 shall have such a value that the fringe which it projects, shall, within a reasonable distance of the pole-piece, be equal and opposite to A_3. A_2 should evidently then bear some definite relation to A_3, and, in order to ascertain this relation, the author, when manager to Messrs. Paterson & Cooper, had a number of machines tested by increasing their loads until the first sign of sparking appeared, and then taking the amperes, volts and speed. From these particulars the ratio $\frac{A_2}{A_3}$ was calculated, and it was found that for his then standard type of machine, having wrought-iron magnets and Gramme armatures, the ratio was 11·25, irrespective of the size of the machines.* In this case A_3 represented the ampere-turns per section of the armature and not the whole magnetising ampere-turns under the brush, but as the machines were all similar in type and general proportions, this was not material.

In present day machines we have different conditions to face. The use of motors causes generator loads to vary frequently and very widely, and as it is not practicable to continually alter the brush rocker the machine must work with a fixed position of brush, so that the condition in which $N_1 - N_2 = 0$ is no longer obtainable over the whole range of load. The mechanical stresses due to these sudden changes of load make slotted armatures necessary, and this gives us short air gaps.

We have further, at the present day, two classes of machines to deal with:—Firstly, machines running continually in one direction and in which it is possible to give some lead to the brushes, and, secondly, those which have to reverse, and in which the brushes have to be fixed permanently midway between the poles, and which consequently have no lead. In both classes sparkless collection depends upon the voltage in the short-circuited coil being kept within a certain value.

If with the first class of machine in actual working we place the brushes in such a position of lead, that at half load, or preferably at the average load, of the machine, $N_1 - N_2 = 0$, we shall at that load have no resultant voltage in the coil (or at any rate a negligible amount), and at any other load the voltage will be a plus or minus quantity expressed by formula No. 3,

$$r = \frac{\pi\,(N_1 - N_2)\,m}{s} \times 10^{-8}. \qquad (3)$$

As we have seen from formula No. 2, r varies with the length of armature and also with the speed, so that in designing present day machines both the length of armature and the speed must be taken into consideration, which was not the case with machines of older types.

Having found from experiment the maximum value of r which will give sparkless collection with carbon brushes, we can calculate by formula No. 4 the field corresponding to this value.

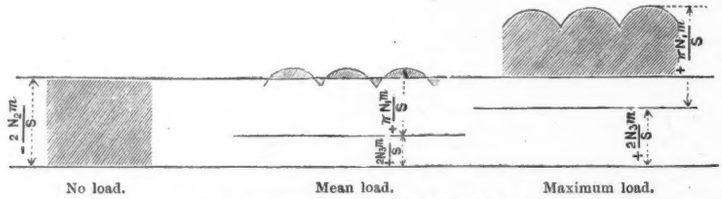
$$N_x = \frac{r\,t}{\cdot 1645 \times D\,R\,m} \times 10^8, \qquad (4)$$

N_1 being equal to $f\,l\,c\,m$, the value of the reversing field in the fringe requires to be N_y, which equals $N_1 - N_x$, or if turned into ampere-turns A_x equals $\frac{N_y}{f\,l}$, and A_2 will equal A_x multiplied by a constant as in the case of the older machines.

In addition to the field produced by the current in the coils undergoing commutation we have to remember that there are two other fields tending to generate E.M.F. in these coils. There is the field due to the current in the adjacent armature coils which tends to increase the E.M.F. in the short-circuited coils, and that due to the fringe extending from the pole tips, which will increase or decrease the E.M.F. according as the lead of the brushes is positive or negative. Thus the resultant voltage in the short-circuited coil may be expressed by the general formula No. 5:

$$e = \left(\frac{\pi\,N_1\,m}{s} + \frac{2\,N_3\,m}{s} \pm \frac{2\,N_2\,m}{s}\right) \times 10^{-8}. \qquad (5)$$

The ideal relative arrangement of these fields to be aimed at in designing machines to run continually in one direction is shown in figs. 6, 7 and 8, from which we see that the brush must be set in such a position that at no load the voltage generated in the short-circuited coil by the fringe is insufficient to set up sparks, and that at full load the reactance voltage plus that due to the field created by adjacent armature coils does not exceed that due to the fringe by an amount sufficient to cause sparking.



The shaded part represents the voltage in the short-circuited coil.

FIG. 6. FIG. 7. FIG. 8.

In the case of reversing motors the most one can do is to make the second and third items cancel each other and adopt such proportions for the machine as will keep the first item within sparkless limits.

In designing machines on the foregoing lines it will be

* See ELECTRICAL REVIEW, August 23rd, 1895.

found that for some outputs the requirements of the preceding formulæ can only be met either by an inconveniently large number of poles or a number of commutator bars so great that the individual bars become too thin for practical purposes.

It then becomes a question whether a heavier design shall be adopted, or whether the light design shall be retained with a reasonable number of poles or commutator bars and sparkless commutation obtained by means of one of the special windings which have from time to time been patented and which are too well known to need description here.

THE PROFITABLE SALE OF ELECTRICITY.

THE discussion on Mr. Arthur Wright's Institution paper brought out the views of some company managers, but it was an argument of expediency against rationality. As Mr. Langdon said, the paper bristled with questions for discussion, which were, however, not discussed. It is always well to go carefully into the other side of a question, but as Mr. Madgen put it, the attacking party as a general rule apologised for not fully understanding the arguments in the paper, and it certainly seemed that this was the case. While we are far from asserting that those who thought that Mr. Wright had not propounded an ideal tariff were unable to follow the reasoning which led the author to it, we cannot glance through the notes of the discussion without feeling that conservatism, the desire for simplicity, or as it is put in the paper, "a fear of displeasing early closing constituents," is at the bottom of opposition.

Mr. Dawbarn thought the diagram showing the percentage return on capital allocated to each class of consumer (at various load factors) was interesting, because it showed the tariff was not perfect and did not satisfy all the conditions to be met, and nothing was said as to the method of dealing with extreme cases. Also, as the author admitted in the paper, that the cost of the instruments (demand indicators) might absorb the profits on a 1 per cent. increase in load factor, the addition of such non-productive devices might cost as much as their use added to the revenue. As time went on, and lighting became more and more electrical, the demand indicator seemed to Mr. Dawbarn to become less and less important. Further, he went so far as to say that he did not see why a supply company should differentiate between one man and another in the same class. It might be advantageous to utilise indicators in the case of 10 per cent. of consumers, but he could not see why the other 90 per cent. should also be provided with them.

Mr. Highfield admitted Mr. Wright's contentions, but considered that an engineer should strive to obtain every possible class of business, and in a town where the flat rate was in vogue, he had been unable to change. The indicator certainly operated against the short-hour shop load, and the difficulty was to explain the system to the consumer. He would rather have a lower price for two hours' initial rate than the higher price for one hour. At St. Helens the diversity factor was high, owing to a motor and tramway load, and to gain a motor load the price had to be low enough to compete with gas, so he had adopted the sliding scale of 2d. for two hours, and 1d. after for power, which came in well. As early closing shops came on readily, they proved an excellent advertisement, and were entitled to some consideration.

Mr. Patchell showed that it was not essential to use a demand scale to attain to a high load factor, as his company had reached 28½ per cent., so they did pretty well on a uniform rate. The average consumer was not interested in 8d. and 2d. as much as in a uniform 6d. or 4d. per unit. On the technical point of class of peak-load plant, Mr. Patchell was with Mr. Wright entirely. With a peak-load non-condensing plant he had generated 25 per cent. of the units, leaving the more efficient condensing plant to turn out the remaining 75 per cent.

Mr. Mordey considered the paper closely reasoned, but he believed the consumer would rather pay 5d. for something he understood than 4¾d. for something he did not. The ideal tariff was based upon the theory that the consumer had installed in the station a certain amount of plant upon which he had a call. Supposing the consumer went to church, then one or two lamps in his private premises would be turned out for every lamp lighted in the church. The same argument applied to ball-rooms and places of public resort. The whole argument seemed to be given away by short-circuiting the demand indicator for an evening or so a month at the request of the consumer. People would not readily change their habits simply because they happened to have a demand indicator in the house. The load factor had improved in Brighton it was true, but it had grown elsewhere where indicators were not used. The indicator told against the use of electric light in the way that gave the greatest convenience, and therefore might prevent the installation of lamps. The whole of the customers of a station ought not to be penalised because a few were not easily charged on a flat rate. The indicator was non-productive, and such apparatus should be reduced to a minimum, as it absorbed pressure and the light went down as the cube of the pressure. An analogy would be for a railway company to charge 1s. for a traveller going on to the platform and ¼d. a mile travelled afterwards, but he considered that simplicity of apparatus and methods of charging was what ought to be aimed at.

Mr. C. P. Sparks believed that one class of short-hour consumers counteracted another class. He showed that different areas in London taken together would give a result diverse from that of any one area in the metropolis or that of a provincial town. By combining different areas a great diversity factor was reached. He cited the good load factors of the many municipal stations as attributable to the public lighting which had a marked influence on Corporation accounts. We fancy from what is reported from time to time that many municipal engineers would differ from Mr. Sparks in this contention, and would tell him that the public lighting is very often a source not of profit but of loss, being undertaken under the pressure of public opinion at rates that are less remunerative that those of private supply.

Mr. Minshall spoke feelingly of the exceeding unpopularity of the maximum demand system, but admitted that at the same time it had the effect of getting the right class of consumer. In the case of a flat rate of 6d. being superseded by a sliding scale of 7d. and 2d., the average might be reduced to 4¾d. per unit, but the public generally failed to appreciate the change. In his own case at Croydon he had scales provided on the demand indicator which showed the number of units to be taken at the initial price, and issued a form of account in which the units were charged at the average rate per unit, with the figures made out on the demand principle in very much smaller type. He thought that plant was often chosen rather by predilection than by predetermination, and referred to the new Edinburgh peak load station, which was not fitted with auxiliary plant, such as economisers, &c.

Mr. Percy Still gave an example of the worst possible class of consumer, early closing shops, which used the light only six months in the year, and showed how desirable it was that such customers should pay their proportion of the capital charges before they reached the lower price per unit.

Mr. Aron naturally favoured the Kapp principle of a two-rate meter, and even ventured to talk of a three-rate meter. His contribution to the discussion was of value, as showing that such instruments are coming into use where there are, or there are thought to be, local objections to the demand indicator principle.

Mr. Leonard Andrews referred to the large variation between quarterly accounts if, as at Brighton, the rebate was only allowed half yearly. He had found that with alternatives of 6d. per unit and 10s. per 8 C.P. lamp per annum with 1½d. per unit consumed, having been permitted to explain to those who came to him the operation of the two scales, 65 per cent. of the total output (or 400,000 units) was sold on the latter basis at an average return of 3½d. per unit, but these units were taken by less than 25 per cent. of the customers.

Mr. H. L. P. Boot complained of the first cost, repairs and maintenance, resetting, and the accuracy (or inaccuracy) of the demand indicator. These disadvantages were very serious, and required the consideration of the station engineer. The system had to be properly explained to each consumer. It did not take account of the time at which

each customer made his maximum demand, and the higher rate should only be charged if that coincides with the peak on the station. He considered the coal costs under the head of "preparation expenses" in the paper were very high compared with the total costs. The present system of free wiring he had found a failure, so far as getting lamps was concerned.

Mr. J. R. Dick preferred to call the Wright indicator an "investment meter." He generally discussed the tendency on the Continent and in the United States towards proportioning the investment charges upon the various consumers, and thought that too much stress might be laid upon the objection of consumers who had no feeling against taking an article below cost price.

The most useful items in the discussion were the speeches of Mr. W. L. Madgen and Mr. H. R. Beeton. On account of the commercial interests controlled by these gentlemen, what they said carries weight that no mere academic argument possessed. Mr. Madgen thought the discussion had brought out distinct evidence in favour of the "ideal tariff," and the objections were vague. He had carefully considered the rates to be charged under the Power Bills, and had found evidence in favour of a sliding scale from the variations of the load factor from different stations in the country. Two examples from the provinces:—

Portsmouth, with uniform price, now 4½d. per unit.—In 1896—97, load factor 14·51 per cent., had decreased in 1900—01 to 12·01 per cent.

South Shields, with sliding scale.—In 1897—98, load factor 11·31 per cent., had increased in 1900—01 to 12·24 per cent.

The uniformity of results in similar cases was the justification for drawing general conclusions.

Two examples from the Metropolis :—

Islington, with sliding scale.—In 1897, load factor, 9·82 per cent. had increased in 1900—01 to 15·31 per cent.

St. Pancras, with flat rate.—In 1893, load factor 19·74 per cent. had decreased in 1896—97 to 11·94 per cent., and with the adoption of a sliding scale, had again increased to 15·09 per cent.

As a one-hour consumer actually cost 7d. per unit to supply, there was no ground for selling an article in general demand at something under cost. If this were done, the more consumers obtained the greater the loss, and then a tariff deadlock must ensue to be finally followed, if the sales continued to be unremunerative, by a financial deadlock. The price must be based on the cost of production if this were to be avoided, and the ignorance and prejudice of the consumer must not be permitted to stand in the way.

Mr. Beeton twitted engineers with the lack of sufficient attention to commercial questions. They ought to consider efficiency of capital as well as efficiency of plant. While they should aim at selling as much electricity as possible, the sales must be upon a profitable basis. The sliding scale ensured in the very nature of the tariff that no consumer could be supplied at a loss, and the sales to all were made at a reasonable profit. It was no objection to the tariff system that Mr. Wright advocated that it was not a perfect system. Any system which attempted to encourage the use of electric light in brilliant sunshine would result in very poor business. Too much had been said about conciliating the consumer; if the system earned the approval of the experts, few would cavil at it. It gave people an intelligible tariff. The object was to reduce the price of electric light. Lowering a flat rate increased the loss on a business which was already losing. The sliding scale was based on undisputed principles.

The discussion left matters very much where they were. No speaker attempted to deny the grounds Mr. Wright took up in the first portion of his paper, but many argued against their application. In short, where a flat rate has been in force it may be difficult to change to a rational sliding scale. Hanley, Blackpool, Croydon and St. Pancras have been through the fight and know the cost. Consumers never will as a body grasp the meaning of Mr. Wright's paper, but while companies like Mr. Patchell's and corporations like St. Helens retain a flat rate, the advocacy of Mr. Madgen and of Mr. Beeton and the examples of the Electrical Power Distribution Company and the Brompton Company may prevent new concerns from commencing on a uniform price when they are at liberty to select a tariff which will differentiate between paying and non-profit-yielding consumers, even if at the start they have to suffer slightly from a cold reception of their advances by the fashionable stores, early-closing offices, and churches in their districts.

CALDWELL'S RÖNTGEN RAY STEREOSCOPE.

In the *Electrical Review*, New York, of November 16th, a description is given by Eugene W. Caldwell of a new apparatus which he has invented for obtaining stereoscopic views of objects rendered visible by the Röntgen rays. Mr. Mackenzie Davidson, as our readers are aware, has already constructed successful instruments for this purpose. Mr. Caldwell's apparatus is intended to obviate certain difficulties which have arisen in the practical use of the Mackenzie Davidson instruments.

One objectionable feature in the Mackenzie Davidson stereoscope is the use of two X-ray tubes, to produce the different images for the two eyes. Now, it is exceedingly difficult to keep the illuminating power of the tubes exactly equal, even though they have been as nearly as possible equal to start with. Mr. Caldwell gets over this difficulty by using a single tube with two anti-cathodes. In the second place, the use of a stationary fluoroscopic screen in the Mackenzie Davidson apparatus makes the apparatus somewhat clumsy for the examination of injured and tender limbs. These must be handled carefully, but sometimes it is impossible to place them in proper position before a fixed screen without causing great discomfort, and even running the risk of causing further injury. Mr. Caldwell obviates this objection by making the screen detached from the rest of the apparatus, and portable.

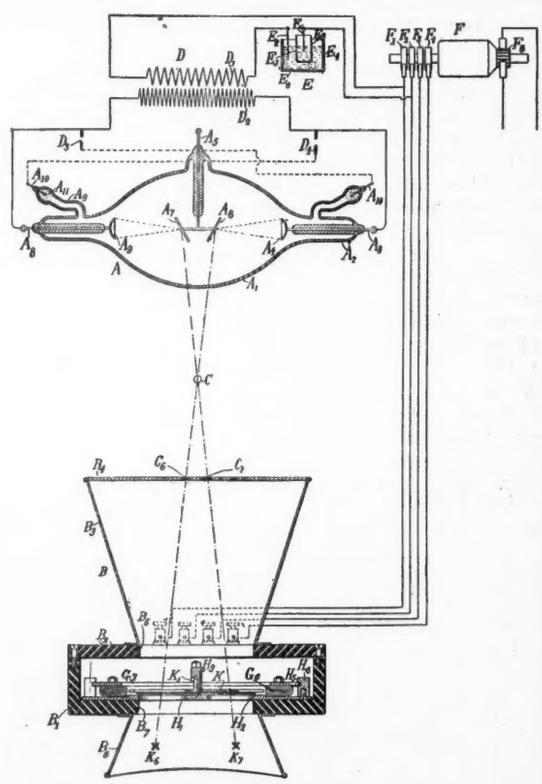


Fig. 1.

Fig. 1 shows the general arrangement of the Caldwell stereoscopic apparatus. The Röntgen rays proceed alternately from the two anti-cathodes A_6 and A_7 of the double X-ray tube A, the cups A_4 and A_5 being alternately cathode and anode.

The primary D_1 of the induction coil D is energised by alternating currents, which may be obtained from an alternating public supply, the break used in the primary circuit being preferably a Caldwell electrolytic interrupter E. Under these conditions the high pressure currents induced in the secondary coil D_2 are alternately in opposite directions, and the X-rays proceed alternately from the foci on the anti-cathodes A_6 and A_7. The intensity of the rays from A_6 and A_7 will be generally equal, as both bundles of rays are produced in the same tube, and will undergo the same changes if the vacuum in the tube changes. When the system is operated with an alternating current of 60 cycles per second, there will be produced on the fluoroscopic screen 7,200 X-ray shadows per minute, each lasting for an infinitesimally short time. If the shutter is properly adjusted 3,600 of these shadows are visible to one eye of the observer, and the alternate 3,600 are seen by the other eye. This rapid succession of images gives the effect of continuous vision by each eye of the fluoroscopic picture seen by that eye, thus imitating very closely normal binocular vision and showing the shape and space relations of the object examined.

A revolving shutter to ensure that one eye always sees the image on the screen produced by the same focus and not the image from the other focus, is essential in apparatus of this kind. The revolutions of the shutter must be exactly synchronous with the alternations of current in the X-ray tube. Mackenzie Davidson obtained synchronism between excitation of the tubes and the movement of the shutter by attaching the interrupter, or the switch mechanism for the tubes and the shutter to the same shaft, which was usually rotated by an electro-motor. Caldwell, however, aimed at making his screen portable, and had therefore to devise some flexible mechanism for imparting the synchronous movement to the shutter. This he effects by rotating the shutter by a small synchronous alternating-current motor. This motor may be of the monophase type, in which case the revolving shutter is made of steel and magnetised; but it is preferred to use a polyphase or split-phase field winding, and make the rotor of soft iron. The shutter motor is, of course, supplied with alternating current from the same source as the induction coil, and therefore operates synchronously with the alternations of current through the coil, and the discharges through the double focus tube.

The stator of the shutter motor is arranged so that it may be turned around the axis of its armature by means of the knob G_8, fig. 2. This is for the purpose of adjusting the time of opening and closing the sight holes with reference to the periodic excitation of the X-ray tube. It has been found best to use a six-toothed or six-pole disc (shown at K, fig. 2) for the shutter. Such a rotor, with a properly wound stator (figs. 4 and 5), makes one-sixth of a revolution for each alternation of the current, and when operated from a public lighting circuit of 60 cycles per second, makes 1,200 revolutions per minute—a thoroughly practical speed for such a structure. If the stator of the motor be turned through one-sixth of a revolution by means of the knob G_8, the action of the shutter will be reversed, and each eye will see the X-ray shadow formerly seen by the other eye. The effect of this is to make the object under examination appear to be seen from the opposite side.

The system admits of many modifications to adapt it to various conditions of current supply. The simplest way to operate the system from a direct current lighting circuit is to use a small rotary converter (F, fig. 1) having collector rings from which a single-phase alternating current may be taken to supply the coil, and a two or three-phase current for operating the shutter. Instead of the rotary converter a rotary reversing interrupter, shown in fig. 6, has been used. This interrupter breaks the current and reverses the direction through the coil twice in every revolution. The "break-wheel" is mounted directly upon the shaft of a small direct-current motor. The armature winding of this motor is tapped at three points, from which three-phase current is taken through collector rings for operating the synchronous shutter.

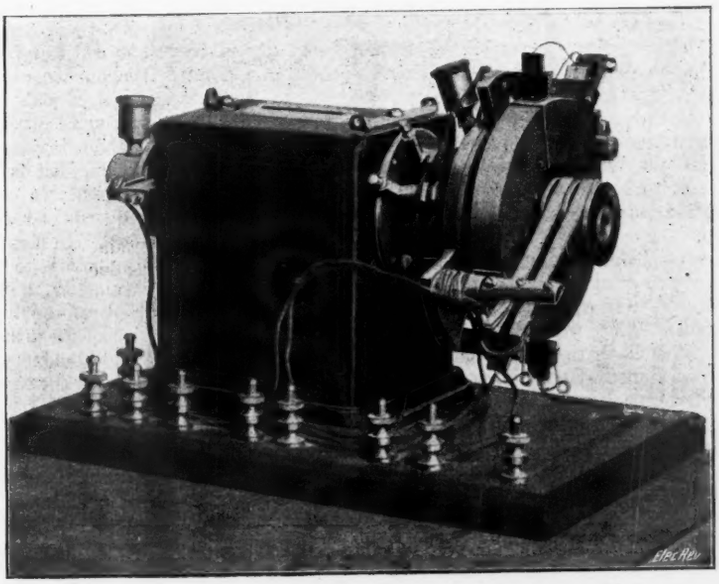


Fig. 6.

In order to adapt the system for use with an influence machine for exciting the tube, such a motor could be arranged to operate a rotary switching apparatus which would change the connection of the negative terminal of the

machine from one concave electrode to the other, the positive terminal being connected permanently to the "anti-cathode."

It would appear at first sight that it would be impossible to hold the screen in exactly the proper position with reference to the X-ray tube, but it is found in practice that the

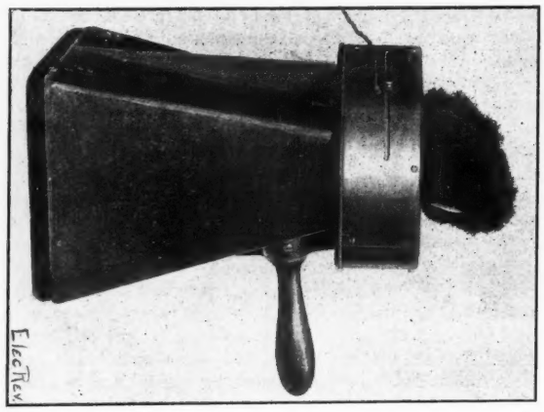


Fig. 7.—Fluoroscopic Screen, with Revolving Shutter.

observer readily recognises any inaccuracies in the fluoroscopic picture of external or known parts, and that unconsciously he will move the fluoroscope until the outlines which are familiar to him assume their proper form, whereupon, of course, the internal parts will be shown correctly.

DISTRIBUTION CABLES FOR THREE-PHASE WORKING.

For the distribution of energy by three-phase currents a simple three-core cable has hitherto been generally employed. If a fourth, or neutral wire, is added, as is well known, the balancing of the system is greatly improved, but it does not appear to have been realised by engineers that the introduction of this fourth wire does for alternating currents almost exactly what the three-wire system of Hopkinson did for continuous currents, as regards reducing the amount of copper required for the mains.

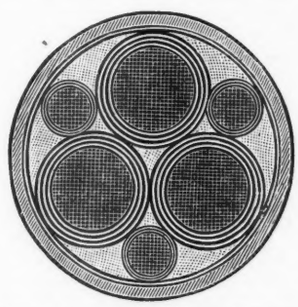
The three-wire system has, of course, been applied to single-phase alternating currents frequently, and the usual saving of copper over a simple two-wire system has been effected thereby; but then there is always cropping up the difficulty as regards power, and, notwithstanding all the claims put forward from time to time for single-phase motors, it cannot be denied that these are still at a very serious disadvantage as compared with those of the polyphase class.

Three-phase working brings to the alternating current system the great advantage of being able to operate motors with a success equal to that so long realised in continuous current working, while the addition of the fourth, or neutral, conductor places the system practically on a par with three-wire continuous systems as regards copper. So worked, we are justified in asserting that alternating currents are placed on the same commercial basis as continuous currents, and if it is necessary, on account of distance, to transmit to distributing centres by three-phase current, the question may not unnaturally be asked why, for work other than street tramways, should the polyphase be converted into continuous current at all?

As regards three-phase distribution, the objection may be raised that a multiple cable is more expensive than a triple concentric, but though the latter has been until recently in almost universal use for three-wire continuous current work, the serious objection to having to cut the conductors at every consumer's box cannot be overlooked; indeed, three-core cable is, on account of this objection, rapidly coming into use for continuous currents. On this count, therefore, little can be urged against the alternating current system.

To demonstrate the saving in copper due to the presence of the neutral wire in polyphase working is quite easy. When a simple three-core cable is employed, the consumer's service wires are for lighting purposes attached to adjacent conductors, but when a fourth or balancing wire is added, the consumer's service wires are connected between any one of the three principal conductors and the fourth wire. From this it follows that if in each case the difference of potential in the consumer's premises is the same, the pressure between the three principal conductors can, when a neutral conductor is added, be increased over the pressure between them when there is no such conductor in the ratio of $\sqrt{3}$ to 1. In other words, while retaining the same pressure at the consumer's terminals we can, when there is a fourth wire, raise the pressure on the three wires in this ratio, and seeing that the weight of copper is inversely as the square of the pressure for the same percentage loss, so far as the three principal conductors are concerned, the weight of copper is at once reduced to one-third. Let the neutral conductor which has to be added, bear the same proportion to the combined area of the principal conductors as in the three-wire continuous system, and we have the total weight of copper with neutral as only five-twelfths of the weight of the three-core cable, that is, considerably less than half.

The advantage of using a neutral conductor for three-phase distribution will then be apparent, and the only problem is how to best place this relatively to the principal conductors. It has been proposed to strand this conductor



Esson Cable for Three-Phase Distribution.

over the three main cores after they have been laid up, but this considerably increases the outside diameter of the cable, at the same time making the jointing very difficult, while another proposal has been to strand the fourth conductor up with the other three, which arrangement is unsymmetrical and will throw the balance of the system out, besides making the outside of the cable larger than it need be. In Mr. W. B. Esson's cable, illustrated above, the neutral conductor is divided into three parts, and with regard to the principal conductors these are placed in the positions shown on the sketch, that is to say, each in the external recess formed between two contiguous principal conductors, so that, like the principal conductors, they are disposed in triangular form. In manufacturing the cable, the separate constituent conductors are laid or twisted along with the three principal conductors, and may or may not be separately insulated. If separately insulated, the covering may be less heavy than that of the principal conductors. The cable thus formed is lapped outside and lead covered in the usual way, the space between the conductors and the lead being packed with jute or other filling. The three constituent conductors of the neutral wire are united at each joint box in a very simple manner, and one of the consumer's connections is made to this, and the other by an ordinary tee joint to one of the principal conductors. It is worthy of note that the space which in this cable is taken up by the fourth wire would in an ordinary three-core cable be filled by jute or other worming; accordingly, it may be said that so far as the outside diameter of the cable is affected the neutral wire takes up no room at all.

Amongst the advantages claimed for the cable described are reduction of weight, and, consequently, of cost, as compared with other three-phase cables with a neutral conductor. There is increased flexibility and greater facility in laying, while on account of the smaller external diameter there are less drums required. The manufacture of the cable is simple,

as all the conductors can be laid up at one operation. There is, owing to the disposition of the conductors, perfect electrical balance and small electrostatic capacity. There is no cutting of the conductors at the consumers' service boxes. We have no doubt, therefore, but that Mr. Esson's invention, which comes along at a most opportune time, will be found to fill a want which would otherwise have made itself unpleasantly felt by engineers adopting three-phase distribution. No instance of this as yet exists in this country so far as we are aware, but the important scheme which Mr. Hammond is carrying out at Dublin on this plan will, no doubt, be followed by others, especially as the manufacture of induction motors will shortly be freed from the restrictions imposed by the Tesla patents.

THE TRANSFORMATION OF THE UNDERGROUND RAILWAY.

II.

As instructed in their minute of May 23rd, 1900, Mr. Thomas Parker presented a report, dated June 9th, to the directors of the Metropolitan Railway, on the electrical train described in our last issue, and its adaptability to the haulage of their traffic on the Inner Circle.

In this report he relied upon the figures given by Sir John Wolfe Barry and Sir William H. Preece, and attempted a comparison between the Underground experimental train and the Liverpool Overhead trains, from the working of which, during the previous seven years, he was able to possess himself of what he considered to be reliable data.

We need not go into Mr. Parker's particulars, but will content ourselves by giving his conclusions from a consideration of the following features:—

"The great dead or pounding load of 8½ tons per axle of the motors being impracticable and ruinous to the permanent way, and would incur heavy maintenance costs and risks."

"The unnecessary weight of the motor-coach of 54 tons, and the weight of the coaches, making up a very much heavier train than is necessary, thereby requiring large generating station plant outlay, and continual energy, costs, and conductor installation costs to obtain the necessary acceleration."

The concluding portion of this latter feature seems more or less unintelligible, but nevertheless Mr. Parker gives it as his opinion that the train would not be efficient or satisfactory for the purpose of hauling the Inner Circle traffic.

The doctors having thus disagreed, the breach was still further widened by yet another document, dated July 4th ("Independence Day," as the sarcastic tone in which it was couched clearly indicates), from Messrs. Barry and Preece on Mr. Parker's report.

They premise their remarks by stating that in the conduct of the experiments between Earl's Court and High Street, they always had in view the future working by electricity, not only of the "Inner Circle" traffic, but also of a great proportion of the traffic which originates or terminates at suburban stations outside the Circle, and, in addition, the foreign, or outside railway traffic, which would, presumably, continue, in the first instance, to be hauled by steam locomotives before coming on to, and after leaving, the companies' systems. Therefore, it was necessary that the weight and power of the experimental motor coaches should be adequate to provide the requisite amount of adhesion for starting and hauling a train of the type now in use.

Mr. Parker having altogether neglected the foregoing vital considerations, Messrs. Barry and Preece politely intimate that his report possesses but little value from the practical standpoint of the general introduction of electrical traction on the companies' lines as a substitute for steam power.

They also show that the system in use on the Liverpool Overhead Railway would not fit in with the exigencies of traffic on the London Underground, and they characterise his comparison of the weights of the experimental and Liverpool trains as being altogether misleading.

His comparision is, however, in other respects equally misleading, according to his opponents; his remarks as to the speed of the experimental train showing no improvement over the present running time of the ordinary trains are said to be entirely incorrect, as also are his observations as to the braking of heavy trains; and Mr. Parker's bad quarter of an hour winds up with the point blank suggestion that his opinion on these points is not perhaps entitled to serious attention.

Generally, they make hay of Mr. Parker's report and triumphantly vindicate their own position.

Finally, the collaboration of Messrs. Barry and Preece comes to an end with a general report and recommendations to the chairmen and directors of the Metropolitan and Metropolitan District Railways, dated August 20th, 1900.

Here it is stated that the working of the experimental train had been of the greatest value in enabling them to arrive at a just appreciation of the many obstacles and difficulties which have to be surmounted when introducing electric power in lieu of, or in conjunction with, steam on the companies' lines, and it is also demonstrated that trains can be efficiently operated electrically without interruption of traffic or material interference with existing conditions.

"To equip and work electrically in the first instance an entirely new line, such as the Central London or the Waterloo and City Railway, is a simple problem as compared with the introduction of electric traction on railways such as the Metropolitan and Metropolitan District."

There are few, we imagine, who would feel disposed to challenge this statement of the consulting engineers, and it seems to us to add weight to the award of the Board of Trade umpire, who has wisely decided that only a known and well-tried system shall be adopted by the two companies.

The engineers then go exhaustively into the question of rolling stock, and recommend as a preliminary measure for handling traffic electrically:—

1. The provision of a suitable number of locomotives for operating other than Circle trains; and
2. The provision of two or more complete new trains on the multiple-unit system for work on the "Inner Circle."

There is now no need to enter into particulars as to the type of locomotive proposed, or to dilate upon the second recommendation; suffice it to say, that the idea was for the existing trains on the "Inner Circle" to be gradually replaced, as opportunity arose, by the new stock adapted to the multiple-unit system, the principal advantages of which, as compared with haulage by electric locomotives, are enumerated as follows:—

1. Decreased axle loads, resulting in decreased expenditure in maintenance and renewals of permanent way, and less vibration;
2. A greater proportion of weight is available for adhesion, and consequently increased acceleration in starting trains is obtained;
3. Increased "mobility" of trains, or, more precisely, of each section of a train, so that the length of trains can be regulated to suit traffic requirements; in other words, separate trains can, if desired, be connected together at junctions, and proceed as one, and *vice versâ*.

For the arrangement of conductors, three alternatives were possible:—

1. Between the track rails.
2. Outside the track rails, as tentatively adopted at Earl's Court.
3. Overhead.

After pointing out at length the advantages and disadvantages of the three methods, the engineers plumped for the "overhead," if the difficulties attendant upon its adoption could be surmounted.

On the "generating station" part of the report we give only what the engineers take to be the main points for careful consideration in selecting sites:—

1. A central position, having regard to the system to be operated electrically.
2. An abundant water supply for condensing purposes.
3. Facilities for the supply of coal and the removal of ashes.
4. The selection of a manufacturing district where the presence of a generating station would not be objectionable.

The conclusion at which the experts arrive from the experimental train, and as the results of practical trials in

America and elsewhere, is that the net resulting benefits to the companies which would follow from the introduction of electrical traction are so considerable, as to make it clear that the change *should not be delayed*.

But the two companies came to a deadlock over the system to be jointly adopted, and now, some year and a half after Messrs. Barry and Preece gave their advice, they have been forced to make a beginning upon work which might by now have been almost completed. As it is, the long-suffering Underground travelling public must rest content to wait two long years at least before they can enjoy the benefits of greater speed and comfort, and the shareholders a like period before the advent of heavier trains with increased carrying capacity, additional receipts, and reduced working expenses per train mile will swell their dividends.

CORRESPONDENCE.

Towns and their Systems of Electricity Supply.

It is a long time since I noticed that most of those towns having names ending in "Chester" have continuous current stations; "Chester" is, as we know, derived from "Castra," meaning camp. So these towns from the earliest times were rather congested, and as one should expect, have adopted the continuous current system, as is the case in the following towns:—Chester, Manchester, Colchester, Winchester, Gloucester and Lancaster.

Lately, I have examined a list of central stations, and noticed that most of those ending in "ford" have also continuous current stations. The termination "ford" implies that they originally sprang up at places where the rivers were fordable. The ford constituted itself the natural centre of the town, and as time went on the town grew around it.

On the other hand, those towns situated at the mouth of rivers, as the termination "mouth" implies, are more scattered, owing to the river being wide. In these cases the river has constituted itself as a neutral axis, tending rather to spread the town over wide areas; so that in most cases the alternate current system has been adopted.

The following lists of towns support these theories, for it must be admitted that they constitute in themselves something more than a coincidence:—

Continuous Current Stations.	Alternating Current Stations.
Bradford.	Bournemouth.
Hereford.	Lynmouth.
Guildford.	Monmouth.
Ilford.	Plymouth.
Oxford.	Portsmouth.
Salford.	Tynemouth.
Stafford.	Yarmouth.
Thetford.	

Valentine Ryan.

Dublin, *January 2nd*, 1902.

The Testing and Management of Electric Motors.

In reply to Mr. Abraham, I regret to say that, though present during the tests referred to, I had no authority whatever to interfere with the arrangements of the operators, whose objects have always been, and ever will be, I fear, a source of considerable perplexity to me, and, possibly, to themselves also.

With reference to meter testing, it would be out of place here were I, within the limits of a small letter, to enter with any pretence to details upon a subject at once so comprehensive and important. I am, however, acquainted with the methods usually adopted in meter tests. Briefly these are: The running (or otherwise) on shunt test, and the + and − tests with graded loads. These are, as Mr. Abraham properly pointed out, conducted with current obtained from independent secondary cells operating through a circuit made up of balances, potentiometers, or dynamometers, or any combination thereof, and variable and sensitive resistances. There are, however, other tests favoured of engineers, and held by them to be the most important of the lot, inasmuch as by them meters are tested under their actual working conditions—constantly varying loads. By their adoption many a meter, satisfactory upon *a constant and graded load*, has either been shelved for repairs by the makers' inspector, or has been consigned to the bosom of its fathers. I refer to the "standard and master meter" tests, which are specially applicable to the purposes mentioned in the article.

In conclusion, I beg to take this opportunity of thanking Mr. Abraham for the kindly terms of his criticism, and also for his courteous consideration in the past of

The Writer of the Article.

Wigan Electricity Works,
January 4th, 1902.

Overhead v. Underground Wires.

You were good enough in a recent issue to notice my paper on "Recent Electric Tramway Practice in the British Isles," read before the University College Engineering Society, London, on November 29th, 1901, and as the question of dangers arising to the public, due to telegraph and telephones wires, and also of the interruption of traffic all over the country, has been brought to the notice of the public of late, the following extract may be of interest:—

> It seems to the author that the time has come when telephone and telegraph wires should be laid underground in all our towns, if only to ensure regular telephone and telegraph services, apart from the danger they cause to the new necessity of electric tramcars. However, as it is mostly impossible to get the telephone wires removed, it is essential to *attempt* to safeguard the trolley wire. The best arrangements are probably those stated by the latest regulations issued by the Post Office authorities.

These regulations were then described, and, in conclusion, the author summed up as follows:—

> It is a great pity that it should be necessary for tramway companies to have to protect themselves from falling telegraph and telephone wires. It would seem to the author more satisfactory if the authorities compelled telephone wires to be put underground where they cross or run parallel with overhead tramway lines. It will have to be done sooner or later; why not, therefore, do it at the outset, instead of attempting to make inadequate provision against this danger.

P. T. J. Estler.

The Carriage of Goods by Tram and their Delivery.

May I venture to suggest through your columns how the electric tramway companies of the present age might greatly increase their finances and besides supply a want.

At present the delivery of parcels is somewhat slow, and even telephoning to a post office does not always produce a messenger as quickly as might be desired, so why should not the tramcar conductors be authorised (like the Globe Express Delivery Company, or for that matter like any other van delivery company) to accept parcels of such weight and size as the company might deem proper and deliver them at houses, &c., passed by the cars. Of course there would have to be a uniform charge payable by the consignor at the time of his consigning his parcel to the conductor, and in the event of such parcel being incapable of delivery by reason of the non-existence or departure of the consignee, the parcel would be handed in at the nearest police station to be dealt with as lost property, unless the sender was ascertainable either from some label outside or from some document inside the parcel in question.

Then, too, some regulation would have to be made even as railway companies now make anent the carriage of cycles to the effect that all parcels, &c., were conveyed at the sender's risk, and that the tramway company in no case hold itself responsible for goods of greater value, say, than £10.

H.

Electric Car Equipments and their Maintenance.

I am much obliged to your correspondent for noting one or two points in my paper which I left rather uncertain in the proof copy, though enlarging on them at the time of reading.

First, with regard to single-truck cars and the rough usage they have to stand. The fault lies mainly with the track, especially at points and bits of special work. If points are laid smoothly, a single-truck car can take them smoothly, and it will ride well over good track. Ought not your correspondent rather to pray for the day when track

will not only be laid properly to gauge, with good joints and smooth curves, but will be kept in first-class running order as well?

The lateral movement of the Brill truck is not troublesome at speeds ordinarily attained in urban work, when both track and wheels are to gauge; but it indicates well when the work is getting beyond the powers of a single-truck car. The evils of the long overhang of car bodies can practically be cured by fitting cantilever extensions. These will not help sagging platforms, however, which are caused, as was pointed out in the Review of December 13th, by the action of the hand-brake, which is like "stringing a bow, the wretched car body being the part bent." Here, again, it is not the principle of the thing which is at fault, but the means of applying the power. The sooner that the old direct pull is abolished, and one of the many methods of simple gearing adopted, the better.

The intermittent flow sand valve is only preferred to continuous flow ones which will stick open. In the second line of the paragraph on "Sand Gear," I said "what is required is a *constant* stream of sand, directed to the proper place." The later part of the sentence is quite as important as the former, and generally the more neglected. The central position for the sand pedal is only wanted for the intermittent flow type, not for the continuous, the object being to prevent the motorman locking the brake *under any circumstances* when the car is in motion. The coefficient of friction between brake-block and wheel rises as the speed decreases, so that, for a quick stop, it is absolutely essential for the motorman to keep the brake handle in his hand and ease the pressure from time to time till the car is at a standstill. To do this, it is necessary that his weight should be continuously on his right foot, and he cannot work the sand satisfactorily with that foot as well. If the motormen are allowed to lock the brake, it will be not hard enough on at high speeds, and too hard on at low speeds, the wheels skidding—a loss of efficiency in both cases.

Even in descending a long grade at a steady pace the brake should not be locked, but eased right off occasionally, so that if the wheels have been picked up by any chance, they are allowed to revolve again before any harm is done. The foot-ratchet is responsible for more flat wheels and runaways, and collisions also, than anything else, excepting only the motorman.

The use of the rheostatic brake, even in conjunction with another brake, cannot be recommended. If the other brake is a slipper brake, it is unnecessary, for a slipper brake can very well look after a car by itself; and it will only be in use in hilly districts, which are the very places where you wish to save resistances and motors most. The hand brake is altogether out of the question, for to use two brakes on the wheels, both of which depend on the rotation of the wheels for their efficiency, is dangerous.

The question of a satisfactory trolley head is practically a question of satisfactory overhead work. If the curves are smoothly constructed, with plenty of pull-offs, a definite path given to the trolley through frogs and crossings, and long fingers put to these, so that the wheel has time to steady itself after its sudden jump on to a larger diameter, the existing types of trolley head will do. The standard should be something like this—that the car should be able to round a curve of 35 ft. radius at six miles an hour without anyone looking after the trolley. This is not by any means impossible, but it can only be attained by careful construction, and by examination of the ears, &c., occasionally, to make sure that they are smooth, for a very small rag can throw a trolley off. For keeping the trolley head itself in good order, there is, as your correspondent points out, nothing equal to the nightly oil can. Let me add that the check on the trolley standard to limit the extreme rise of the head should be adjustable.

I have no preference for the Walker method of cutting out a motor. I mentioned it as being the simplest. The gain of another resistance notch is well worth a slight extra complication inside the controller.

One other plea—let the resistances be put under the seats, especially if the car runs in a district where salt is used to get rid of snow. Everything is then dry and out of harm's way. If the resistances heat up, from being used for braking, a sheet of asbestos will save the seat. The heated air is useful in winter inside the car, and in summer can be conducted out by an extractor through the double casement for the sliding door.

A. W. Wigram.

Sunderland, *January 6th*, 1902.

The Tramway Junction at Sheffield.

I read Messrs. Askham's letter in your issue of December 27th, and "Electric's" in January 3rd, during which time I had an opportunity of perusing the original article in your issue of December 13th. From my knowledge of the junction in question, I think Messrs. Askham are quite justified in their statement.

The junction was not designed to obtain the best results in the first instance, and the road was not altered to suit the tramway; a junction was added which was never used, and this crippled the free running of the cars, making the curves too sharp and the leads too short. This has now been abolished, but I suppose the points and crossings are to blame for this from "Electric's" view.

The points and crossings did splendid service under the undue strains thrown upon them, and were not faulty; they would have lasted a very long time had they not been taken up to reconstruct the lines, and Messrs. Askham could have claimed years of life for them.

I have watched cars take this curve, and regularly saw them run off *the rails* (not the points and crossings); this was because the outer rail was too low, and frequently from broken wheels which caused serious damage to the permanent way. I have since seen the new junction, which I observe is already showing signs of wear, and find that the road has been raised and generally altered to assist the present work, in addition to which the absence of the junction referred to has made a great difference.

I have for many years had to do with tramways using Messrs. Askham's work, and I am quite sure that if the line had been properly designed at first, the credit now claimed by another maker would have been theirs.

The two junctions cannot be compared together, as everything is now done to make the junction work easily, expense being apparently no object. Had the original junction been laid with manganese steel, it would have been taken up in the same manner, and possibly earlier. The other portion of "Electric's" letter is irrelevant, and the meaning of his remarks vague.

A Tramway Engineer.

I was much amused to read "Electric's" letter in your issue of January 3rd; it is another example of the "Three Tailors of Tooley Street."

"We engineers," I wonder which class he is alluding to, but no doubt anyone would be proud to welcome the new acquisition, judging by his testimonial. "I do not know another place like it," and because he does not know he presumes no one else does. His origin might be traced by the jealousy (expressed in his third paragraph) of a firm which has supplied more tramway work throughout England than all the other English makers.

Perhaps when "Electric" has had more experience he will not be so desirous to translate inaccurately other people's letters.

B. B.

In our letter of December 18th we stated a fact, which "Electric" in your issue of the 3rd inst. entirely ignores, but distorts our letter and makes statements which can only be made under the shield of anonymous correspondence.

Askham Bros. & Wilson, Limited,

Philip W. Askham, *Managing Director.*

Sheffield, *January 6th*, 1902.

Fire Insurance.

May I bring to the notice of your readers the fact that, in most fire insurance policies, there is what is known as an "Average Clause," the wording of which is very complicated; but the exact legal meaning is, that if a man insures half

the value of his stock or premises and a fire occurs, the company will only pay half the value of the ascertained loss; thus, if a man had stock to the value of £4,000, and he had only insured for £2,000, and he had £1,000 worth of damage through fire, the insurance companies would only pay him £500.

Believing that this is a most iniquitous clause, and not generally understood, I take the liberty of sending you the above letter.

It is also a fact that in London the fire insurance premiums have been increased from 400 to 500 per cent. more than they were six or seven years ago.

Seeing that the companies are, many of them, if not all of them, still paying 20 per cent. and more on their paid-up capital, it seems that the only way to bring them to reason, both in their charges and conditions, is for the general body of ratepayers to insist on municipal insurance; this plan has been adopted in several places with very great success and immense saving to the pockets of insurers.

I enclose my card as a proof of good faith, but not for publication.

A Sufferer from Fire Insurance Rapacity.

BUSINESS NOTES.

Electrical Wares Exported.

WEEK ENDING JAN. 8TH, 1901.		WEEK ENDING JAN. 7TH, 1902.	
Adelaide	Value £82	Adelaide. Teleg. mat. ..	Value £79
Alexandria	20	Alexandria	707
Amsterdam	90	Amsterdam	45
Azores	20	Bangkok	110
,, Teleg. cable	4,950	Bombay	44
Boca. Teleg. mat.	319	,, Teleg. mat.	63
Bombay	797	Brisbane. Teleg. mat.	156
,, Teleg. wire	46	Calcutta	2,138
Buenos Ayres	389	,, Teleg. mat.	194
,, Teleg. mat. ..	1,743	Canada (*vid* the States)	145
,, Teleg. wire ..	204	Cape Town	193
Calcutta	613	Colombo	217
Cape Town	523	Durban	690
Chinde	39	East London	494
Colombo	35	,, Teleg. wire ..	485
Durban	518	Fremantle	154
East London. Teleg. mat. ..	449	,, Teleg. mat.	81
Hamburg	244	Genoa	35
,, Teleg. mat. ..	1,100	Gibraltar	45
Hong Kong	110	,, Teleg. buoys ..	125
Lyttleton	31	Hobart	273
Mauritius	117	Kobe. Elec. cable	1,502
Melbourne. Teleg. wire ..	1,200	Lyttleton	30
Moji	160	Madras	340
Port Elizabeth	27	Melbourne	655
St. Helena. Teleg. mat. ..	1,946	Perth	60
Shanghai	173	Port Elizabeth	118
Singapore	57	Rangoon	16
Sydney	2,042	Rio Grande do Sul	43
,, Teleph. cable ..	1,670	Rio de Janeiro	31
Trinidad	26	Rotterdam. Teleg. wire ..	40
Wellington	724	St. Petersburg	25
,, Teleg. mat. ..	1,241	Santos. Teleg. mat.	139
		Shanghai	143
		Singapore	37
		Sydney	510
		Tokio	80
		Trinidad	26
		Valparaiso	60
		Wellington. Teleg. mat. ..	550
		Yokohama	3,569
		,, Teleg. mat.	93
Total ..	£21,700	Total ..	£14,540

"Ark" Lamps.—Messrs. Johnson & Phillips have drawn our attention to the fact that one of the cardinal features of their "Ark" lamp is that it is made to work on all circuits, alternating or direct current, parallel or series, with but slight change, so that the central station engineer contemplating changing over can do so with greater serenity, since he is not faced with the scrapping of old lamps.

Automatic Lift Controllers.—With regard to the automatic lift controllers made by the Automatic Switch Company, of New York, the G.E. Company (1900), Limited, have received a letter from this company drawing attention to a suit recently instituted by them against the Cutler-Hammer Manufacturing Company in the U.S. Circuit Court, Southern District of New York, for infringement of their Patent No. 499,769, dated June 20th, 1893. It is said that the infringing device is embodied in all of the solenoid type automatic motor starters manufactured and sold by the Cutler-Hammer Manufacturing Company, and equipped with a cut-out for the introduction of resistance in the actuating circuit of the solenoid.

Books Received.—"The Engineering Index, 1896—1900." Edited by Henry Harrison Suplee, B.Sc., and J. H. Cuntz. New York and London: The *Engineering Magazine*. 1901. 30s.

"High Speed Steam Engines," by W. Norris and B. H. Morgan. Second edition, 1902. London: P. S. King & Son. 10s. 6d. net.

"Meteorological Observations made at the Adelaide Observatory and Other Places in South Australia and the Northern Territory during the Year 1898, under the Direction of Charles Todd, K.C.M.G., F.R.S." Adelaide: By Authority. 1901.

"Simple Electrical Working Models," by P. Marshall. London: Dawbarn & Ward, Limited. 6d. net.

Damages for Shock.—A linesman named Wallage has just been awarded £175 damages under the Employers' Liability Act, 1880, against Mr. F. H. Rippon, electrical engineer, of Exeter. While engaged fitting up the Co-operative Stores last September, defendant ordered plaintiff to cut an electric wire which led into the premises. This he attempted to do with a pair of pliers, but as the fuse was not disconnected from the wire, he received a severe shock which had left, according to the medical evidence, severe injuries to his system. Defendant said that he told Wallage to take out the fuse; he denied that he told plaintiff that the wire was all right.

Calendars and Catalogues.—Messrs. W. H. Willcox and Co., Limited, have sent us one of their 1902 Date Remembrancers with monthly sheets.

A handsome perpetual wall calendar comes to hand from the Glacier Anti-Friction Metal Company, Limited, of 91, Queen Victoria Street, E.C. The company have published a small pamphlet giving a few tests and reports on their metal for lining the bearings of engines, dynamos, tramcars, &c.

A calendar and several lists of Willesden rot-proof roofing canvas have come to hand from the Willesden Paper and Canvas Works, Limited, of Willesden Junction, N.W.

Mr. C. E. Schlimper, of Colchester, has brought out a new catalogue of the "Reliance" donkey pump.

The General Electric Company (1900), Limited, is sending out circulars drawing attention to the "Robertson lamp" for use in coronation illuminations.

Mr. F. Winter, of 8, Redcross Street, E.C., sends us a copy of the new price list of the Hamburg India-Rubber Comb Company's ebonite (vulcanite) sheets, rods and tubes.

Messrs. Fraser & Chalmers, Limited, of Threadneedle Street, E.C., have placed before us an illustrated pamphlet describing the Reidler air and gas compressors and blowing engines.

The G.E.C. (1900), Limited, have brought out a new list in which they detail their telephone apparatus, &c., for electric traction systems. These include feeder pillar telephones, pole-fitting and sub-station instruments, portable and central station telephones, and street telephone posts.

Messrs. T. Bolton & Sons are sending out to their friends a handy "Record" diary for 1902. It has memoranda space for each day, and a separate cash account section for the different months.

Messrs. James Armstrong & Co., Limited, of 116, Queen Victoria Street, E.C., have issued an illustrated catalogue and price list of their Midget and reservoir steam traps, also of the International automatic injector, water alarms, water heaters, and oil lubricating pumps.

The Simplex Steel Conduit Company have issued a handy calendar which promises to adorn many an office wall for years to come.

A circular describing their water softening and purifying apparatus comes to hand from the "Desrumaux" Automatic Water Softener and Purifier, Limited, of Bradford and London.

Dissolutions and Liquidations.—The Pioneer Electric Light and Power Company, of China, is winding-up voluntarily. Liquidator, Mr. R. W. Blackburn, 35, New Broad Street, E.C.

The first meeting of creditors and contributories in *re* Harry South and Co. are to be held on January 14th.

Electric Railway Lifts.—We understand that when the Central London Railway Company recently required some additional lifts, they asked both British and American manufacturers to tender. We are pleased to learn that a British firm, Messrs. R. Waygood & Co., Limited, have been successful in carrying off the contract. It will be remembered that the former lifts for this railway were of American make. We stated a few weeks ago that British manufacturers are also supplying the lifts for the Great Northern & City Railway and the City and South London Railway.

Electrical Effects at Pantomimes.—The elaborate electrical effects in the great fan scene in the Drury Lane Pantomime are installed on the E.L.B. system. Several thousand lamps are used nightly. The same system has also been applied for Mr. Moss's large "Cinderella" pantomime at Liverpool.

Electricity for Mines Drainage.—At the monthly meeting of the South Staffordshire Mines Drainage Commissioners on Wednesday in last week, the chairman (Colonel Cochrane) stated that they had been patiently waiting for the Midland Electric Corporation to lay their mains in the Commissioner's district, so that they could put down electrical pumps, and that they were now in communication with that company as to terms. In reply to a question by Sir B. Hingley as to how the sum of £8,644 had been spent on new works, Mr. Marten (surface works engineer) said that a large amount had been spent in anticipatory provision of 25 electrical pumps, for which they were quite ready.

Electricity Tariffs.—Mr. S. Jevons, of Minories, Birmingham, writes as follows:—"My attention has been drawn to your leaderette on the above subject in your issue of December 27th, and it occurred to me that you might be interested to know that I have already supplied quite a number of my automatic time switches for the purposes mentioned, namely, that of switching in and out of circuit, respectively, high and low-rate reading meters

during certain hours of the day. Your remarks might suggest that the application of time switches is still to be adapted for the purpose mentioned. It might be of use to some of your readers to know that the thing is an accomplished fact, and that it can be applied forthwith, if they desire to try it. I am at the present time dealing with automatic time switches, as above mentioned, for capacities up to 250 amperes."

Expanding Pulley.—Mr. A. Lyford, of Loftus Works, Shepherd's Bush, has sent us a specification of an ingenious expanding pulley which he has devised, in which the rim consists of a number of segments with guides sliding in radial slots in two discs. The alternate segments are slightly overlapped by those on either side at maximum expansion, while when the pulley is contracted to the utmost the former are entirely covered up by the latter, whose edges then meet. The diameter is varied by means of links attached to the guides and to sliding collars on the shaft, and by suitably coupling the collars of the driving and driven pulleys by means of levers, worked by right and left screws, a continuous variation of speed can be obtained. Apart from the objections which always attach to pulleys, &c., built up of many loose parts, the device is open to the criticism that the surface of the pulley cannot remain truly cylindrical for all diameters; it consists, in fact, of a succession of elevations and depressions, with the result that there would probably be a good deal of noise and vibration with a belt running at high speeds. For some special purposes, however—and such devices are only used for special purposes—this pulley may be found very useful.

Geipel & Lange.—Messrs. Geipel & Lange inform us that their business during 1901 was the largest on record. The orders for Geipel's patent steam traps have shown a steady increase, and there are now 25,000 of these traps in use all over the world. A new form of separator has been recently introduced to meet the requirements of the higher steam pressures now in vogue. The installation department has been engaged upon a number of important works, mostly of the three-phase "Brown-Boveri" system, for which they hold the agency for the South of England. Amongst others, may be mentioned a 500-H.P. direct driven set which they have supplied to the Burton Corporation for the extension of their power station; a similar set on the three-phase system for the extension of the Patent Shaft and Axletree Company's works at Wednesbury, and a 400 H.P. set for the Bristol Wagon and Carriage Works Company. They have also been engaged upon a number of country and town houses. The business in "Ward-Leonard" rheostats, motor starters and circuit breakers (for which they hold the European agency) has increased very rapidly, the apparatus being used by almost every motor manufacturer in this country. As an example of this business, Messrs. Geipel & Lange mention that something like 2,000 different articles of this apparatus are kept in stock in London ready for the requirements of their customers. The Vulcan electricity meter has met with much appreciation, and is already being extensively adopted by municipal electricity supply works, and the Vulcan pre-payment meter is also being largely used, more especially in combination with free wiring.

Hospital Installation.—The new Maida Vale Hospital for Epilepsy and Paralysis is to be fitted throughout with the latest improvements in electric light and inter-communication telephones; also with the most recent appliances for faradisation, galvanisation and electrolysis, and ophthalmoscopic purposes. The installation will be provided with the newest form of electric baths; and when completed the hospital will be one of the finest of its particular kind in the kingdom. The whole work is being designed and carried out by Messrs. Duncan Watson & Co., of Charing Cross Road, W.C., who are making a speciality of hospital work.

Motor Car Measuring Instruments.—The accompanying figure illustrates an instrument especially designed for motor car

work by Messrs. Nalder Bros. & Thompson, Limited, to meet the demand for a light, compact ammeter and voltmeter. It consists practically of two permanent-magnet moving-coil instruments having a common magnet, thus having the advantage of two scales and pointers, but only the weight of one instrument. The voltmeter can be arranged with either an even or opened scale, as desired, and the ammeter with its zero at the side, or in the centre if it be required for charging accumulators. The instruments are specially dead-beat, and are arranged in one case, which is of aluminium. Terminals can be provided at the side or back, as found convenient.

Petroleum-Spirit Motor and Dynamo.—The success of their motors has led Messrs. De Dion, Bouton & Co., of Puteaux (Seine), to extend their use, and at the recent Salon d'Automobiles, in Paris, they exhibited a small and compact electric lighting set, consisting of a petroleum-spirit motor and dynamo mounted on the same bedplate. The set is made in several sizes. The 3-H.P. motor is connected to a dynamo giving, at a speed of 1,350 revolutions per minute, 15 amperes at 110 volts; a 4-H.P. and a 6-H.P. set (30 amperes at 110 volts) are also made. A feature of the plant is the provision of an electric regulator which maintains constant the E.M.F. of the dynamo at any load. Taking the 4-H.P. set the consumption of petrol is about two litres per hour. This with petrol at 3½d. per litre brings the cost of fuel for running a 10-C.P. lamp to only $\frac{1}{10}$d. per hour. In addition to lighting, the set is recommended by the makers as being specially suitable for charging the accumulators of electric motor cars.

Rating Appeal.—The Chatham, Rochester and District Electric Lighting Company have appealed against the rating of their mains by the Guardians and Trustees of St. Nicholas, Rochester. The application has been adjourned until February 17th.

Smoking Concert.—On 3rd inst. the staff of Messrs. Veritys, Limited, Manchester, held a dinner, followed by a smoking concert, at the Falstaff Hotel, Manchester. The manager, Mr. M. B. Cotterell, presided. This was the first of these gatherings, and its success was such that the function is now to become an annual affair. Mr. Cotterell said that when he took over the management less than three years ago the staff consisted of nine members; the number now was between 30 and 40.

Trade Announcements.—Mr. T. Bernard Hall announces that he has taken into partnership Mr. Laurence A. Jones, who was for some years his principal assistant, and who, during the last three years, has been engaged in Westminster upon important works. The business hitherto carried on by Mr. Hall will, in future, be continued under the style of "T. Bernard Hall & Jones," at 110, Colmore Road, Birmingham.

Mr. E. A. Gilles, who has for some time represented the Sun Electrical Company, Limited, has now joined the Imperial Electric Supplies, Limited, of London.

What the British Consuls Have to Say.—*The Electric Works of Würtemberg.*—Dr. Frederick Rose, his Majesty's Consul at Stuttgart, in his latest report, states that the general and severe depression under which almost all the electro-technical works in Germany are suffering at present, has not affected Würtemberg to any grave extent. The large establishments at Cannstatt, Esslingen, and Stuttgart, during the year 1900 and part of 1901, were well occupied, and only in a few cases were some works compelled to limit their production. The export of electric machinery to South Africa and China is said to have languished on account of the wars. Other countries to which electric machinery is exported from the Würtemberg district are Sweden, Norway, Belgium, Holland, the United Kingdom, France, Italy, Austria-Hungary, and Russia.

The Stuttgart Electric Works during 1900, Dr. Rose reports, increased the number of lamps used by 28 per cent., compared to 1899. These works, he states, have been enlarged by the utilisation, of the water-power of the Neckar at Marbach, where four new turbines have been erected, each of 300 H.P. In addition to these, a new dynamo of 1,000 H.P. was added to the already existing machines at Stuttgart.

Window Lighting.—The following letter, which recently appeared in the *Draper's Record*, is worth noting by contractors:—"How windows should be lighted is a matter of grave consideration, especially in the winter time. Electric lighting has opened up great possibilities in this direction. We may, however, have too much of a good thing. The many miserable failures in this direction are plainly to be seen in most large towns. Occasionally one drops across a success. A window seen recently was lighted solely by electricity at the top. Shades are so arranged as to cast down a flood of light on the goods in the window below. Instead of casting a flood of light on to the footpath, the lights nearest to plate-glass front are shaded so as to throw the light inside, and right on to the goods. This is a great comfort to the window gazer—oft-times a customer. Instead of the eyes being dazzled with the light, they can look comfortably on the stock displayed in the window. The goods stand out boldly, and can be surveyed like a shaded picture. Another tradesman favours the lights being at the bottom of the window, nearest the glass, and shaded so as to throw the light upwards. In this case also the lights are shaded at the front, so that the shaded glare falls on the goods, and not on the eyes of the onlooker. Some shops I have seen lately, especially the mantle shops, are one garish blaze of electric light, unshaded, or nearly so. These are pronounced successes where glare is wanted, but they are sad failures often as a means of selling the articles on view. People not accustomed to the new light cannot bear the unshaded glare,

and so the object of the tradesman is not attained. Experts in these matters should be consu ted. If the result is not successful another system of arranging the lights should be tried." It is an unquestionable fact that, even nowadays, far too little consideration is given to *effective lighting*—not only of windows, but of rooms and streets.

The Charing Cross Co. Summoned.—At Guildhall, on 3rd inst., before Mr. Alderman Crosby, the Charing Cross and Strand Electricity Supply Corporation, was summoned at the instance of Mr. E. Woodthorpe, district surveyor for the northern division of the City, for having commenced to execute certain works without previously serving the notice required by the London Building Act, 1894. Mr. Shiress Will, K.C., appeared for the defendant company. From the *Times* report of the case, it appears that Mr. Woodthorpe said his complaint was that the company had failed to give him notice of the construction of a chamber at the corner of Bishopsgate Street and Wormwood Street underground. The chamber was enclosed within a 9-in. wall. He considered it unsafe to the public through certain defects, which he had pointed out to the foreman of the works. Since the issue of the summons the foreman had told him that the necessary alterations had been made. Mr. Will said he was not there to dispute facts, but to raise a point of law. He submitted that the special powers under which this electric lighting company carried on its works excluded it from the provisions of the Building Act. All their works were carried on strictly under the supervision of the local authority, and, on the dispute arising, appeal was made to the Board of Trade. Plans had to be submitted and passed, and therefore the safety of the public was assured. The local authority in this case, he contended, was the Corporation, and its officer was Mr. Ross, the engineer. The district surveyor, therefore, had no jurisdiction. Mr. W. H. Patchell, chief engineer to the defendant company, was called, and said that, in connection with the construction of power boxes, plans were always submitted to the local authorities. In this case such plans had been submitted to and approved by Mr. Ross. There was absolutely no danger to the public, as these boxes were erected under the supervision of the local authority. The Alderman said the matter was an important one, and adjourned the summons in order to consider his decision.

ELECTRIC LIGHT AND POWER NOTES.

Ashton-under-Lyne.—Since Mr. Neville Applebee took charge of the electricity works several changes have been made. It will be remembered that Mr. Hammond reported on the works some time ago, and recommended alterations at a cost of £5,000. Two generating sets of 250 H.P. each—half the size of the existing sets—are being installed, and the ejector-condensers are to be replaced by a surface condenser. No steam was obtained from the destructor boilers until last summer, but Mr. Applebee is now carrying out alterations which are expected to result in an important aid from this source. The consumption of coal, which cost £4,000 last year, and led to a loss of £900, has also been materially reduced. A change of voltage not often met with is about to be undertaken—viz., from 200 to 240 volts. Seeing that the generators are used alternatively for lighting and traction they are obviously suitable for the higher lighting pressure without modification, and will probably work better with the stronger field; it is difficult, indeed, to understand why the voltage was not fixed at 240 in the first instance. The lamp connection is steadily increasing, and it is confidently anticipated that a balance on the right side will be shown at the end of the current financial year.

Belfast.—The Gas and Electric Committee has decided to supply electrical energy for power purposes, to any consumer taking current for not less than 20 hours per day for five days a week to the extent of at least half his maximum demand, at the rate of 1d. per unit.

Bristol.—The County Council of Somerset has resolved to oppose the Bill of the Bristol City Council, in order to safeguard the interests of the parishes in which the Corporation is applying for powers to supply electricity.

Cardiff.—The Parliamentary Committee will oppose the South Wales Electric Power Distribution Bill unless the promoters agree to except Cardiff from the scope of its operations.

Chester-le-Street.—The R.D.C. has consented to the County of Durham Electrical Distribution Company applying for a prov. order for the lighting of the district with electricity.

Durham.—On Saturday last many of the establishments in Durham city were lighted up for the first time by electricity, which is supplied by the County of Durham Electrical Distribution Company.

Finchley.—In the Bill that has been presented to Parliament by the U.D.C., powers are sought to acquire lands for the generating station; to extend the period in which the Council are to lay their mains until July 31st, 1903; to supply electrical energy in bulk to any adjacent authority or company, subject to the approval of the B. of T., and to remove all overground lines which have been erected without the consent of the Council. Estimates have been prepared by the Council for the execution of the works authorised by the Act, as follows.—For a generating station, £10,000; for electricity purposes, £75,000. Powers are sought to borrow the money for the generating station for 50 years, and in the case of the electricity undertaking application is made for the loan of £75,000 to be granted for 30 years instead of the usual period of 25 years.

Germany.—The Union Electrical Company, of Berlin, has secured an important contract in connection with the large new docks of the Hamburg-American line at Kuhwärder, near Hamburg. In addition to the electric lighting, over 100 electric cranes are to be installed. This work is all to be carried out by the Union Company, as well as the equipment of the power station necessary to furnish the electrical energy.

Gillingham.—In reference to the purchase of the local electric lighting company's works at New Brompton (Chatham) by the Gillingham District Council, the B. of T. have written stating that they could give no information as to their ultimate decision with regard to the granting of a provisional order until the Council had secured the sanction of the Local Government Board to borrowing the necessary purchase-money.

Guildford.—The Guildford Electric Supply Company have nearly completed the erection of new buildings and improved plant, and the extension of their cables. Considerable difficulty was experienced in the matter of foundations, as the site was treacherous at the river side, where the greatest stability was needed. The engineer, Mr. J. M. V. Money-Kent, made the massive concrete bed of the engines carry the river wall by means of cantilevers, and at other parts pile driving was resorted to. The boiler house is a lofty room, 75 ft. long, and 47 ft. wide. It is well lighted by means of a large lantern, running from end to end of the building, and three iron casements in the river wall. The engine room is 20 ft. wide by 60 ft. long, lighted by a long lantern and large iron casements. The floor is paved with tiles, and overhead is a 5-ton travelling crane. The most improved machinery is being introduced throughout the works, with a view to economy in consumption of fuel, such as condensers, superheaters, electric pumps, electric fans for forced draught, and patent stokers. All this work grew up over existing machinery which had to be kept going, and three engines had to be moved to new positions; the whole has been carried out without disturbance to the service of electric current, and great credit is due to the company and to Mr. Money-Kent, the company's engineer, who has exercised the closest supervision over the work. Overtures have been made by the Corporation to the company with a view to the acquisition by the town of the undertaking, but up to the present nothing definite has been done.

Hastings.—A failure of the electricity supply occurred on the evening of December 31st in Hastings and St. Leonards.

Horfield.—The U.D.C. is considering the question of lighting the district with electricity.

London.—CITY.—A series of explosions occurred in the City on Saturday and Sunday last, resulting in injuries to several persons, and to suspension of the supply of electricity in certain areas. Two of the Charing Cross Company's street boxes, near St. Sepulchre's Church, and another box in Newgate Street, were found to be emitting smoke on Saturday afternoon, and when the last-mentioned was opened the fumes caught fire, burning two workmen. Shortly afterwards explosions took place in two neighbouring manholes belonging to the City of London Company, with slight personal injuries. Another explosion occurred in a street box in Ludgate Hill belonging to the City Company, at 2.30 a.m. on Sunday. The supply was cut off from a considerable area during Saturday night.

WOOLWICH.—The Borough Council has consented to an application from the Blackheath and Greenwich District Electric Light Company, Limited, to the B. of T. for a license to supply electricity within the parish of Eltham.

Long Eaton.—Last week Col. W. L. Coke held an inquiry into the application of the D.C. for leave to borrow £15,000 for the installation of an electricity supply scheme.

Manchester.—Mr. J. Phythian, who, until last November, was vice-chairman of the Electricity Committee, has resigned his seat on the Council as the result of an inquiry by a sub-committee into certain charges against him. Mr. Phythian has intimated his determination to again appeal to his constituency, and holds that he is the victim of a vile conspiracy.

During the fortnight ending 5th inst. the output of electrical energy has been 716,165 units, as compared with 491,060 units in the corresponding period of last year.

Rhosllanerchrugog.—The Parish Council has resolved to apply to the Wrexham and District Electric Tramway Company asking if they will supply current for the street lamps, and lay mains.

St. Helens.—A Willans engine of 600 H.P., coupled direct to a 330-KW. generator of the English Electric Manufacturing Company's make, has been installed at the electricity works. A balancing booster of 50 H.P., and new switchboard, and a new cooling tower to deal with the steam from engines of 1,200 H.P., have

also been erected. A new feeder cable 1,500 yards long has been laid from the generating station to the subway in Church Street to distribute a larger supply of energy.

Spain.—A large central electricity generating plant is being established by La Sociedad Electra Industrial Corunesa about 13 miles from Coruna. The water-power of the River Eume is being utilised, and the energy generated will be transmitted to Coruna for lighting and power purposes.

The municipal authorities of Enova (province of Valencia) have just invited tenders for the concession for the electric lighting of the town during a period of 10 years.

Steel Works Plant.—According to the *South Wales Daily News*, Messrs. Guest, Keen & Co., Limited, Messrs. Bolckow, Vaughan & Co., Limited, and the Consett Iron Company, are contemplating carrying out the complete equipment of their works with electrical apparatus. Mr. F. C. Roberts, an American engineer, has been entrusted with the work, which is to follow the lines of American steel works practice, and an expenditure of £1,000,000 on the conversion is contemplated. Messrs. Guest, Keen & Co.'s works at Dowlais and Cyfarthfa will be supplied with electrical energy by the South Wales Electric Power Distribution Company.

Trowbridge.—The U.D.C. has considered the report of Mr. D. Stevenson, the electrical engineer, and has decided that, inasmuch as the borrowing powers of the Council will not for some time permit of a sufficient loan being raised to establish and develop an electricity supply station, the E.L. Committee shall consider the next best course to adopt to supply the town with electricity.

York.—The installation of the electric light in the York prison, which is now in the hands of the military authorities, is almost completed, and it is said that this will be the first prison so lighted. Messrs. A. J. Beaumont & Co., of York, have carried out the work from the city supply, and the installation comprises 375 lamps. Each cell is provided with a 5-C.P. lamp; 8-C.P. lamps are used in the corridors, whilst in the chapel and other larger parts of the building, 16-C.P. lamps are put in. In addition to the lighting, the prison has been fitted with electric bells and telephones.

ELECTRIC TRACTION NOTES.

Aberdeen.—The Tramways Committee of the Town Council had under consideration last week the proposed extensions to the electric tramways. It was decided to introduce the overhead system on the route from Union Street to Queen's Cross and Bayview, and also between the Bridge of Dee and the Bridge of Don. Portions of the latter route which passes through Old Aberdeen will require the permanent way to be relaid and doubled. The estimated cost will be £36,000. The Rosemount section will still be worked by horse haulage in the meantime.

Ayr.—The Corporation electric tramways have now been in operation for three months and have been fairly successful. The receipts to expenses show a margin on the right side. The energy used, it seems, works out at ·85 B. of T. unit per car-mile. The laying of the permanent way to Alloway is about to be commenced.

Blackburn.—The chief clerk in the Corporation tramways department, Mr. J. W. Baker, has issued a report showing the mileage, passenger traffic and receipts on the various routes during the past three years. Dealing first with the Church, Cemetery, Preston Road and Witton routes, the mileage was 423,580 in 1899, 479,530 in 1900, and 564,292 in 1901, the passengers numbering 4,339,644, 4,957,917, and 5,003,712 respectively, whilst the receipts amounted to £21,159 13s. 4d. in 1899, £23,584 9s. 2d. in 1900, and £26,379 9s. 2d. in 1901. The receipts per mile run work out at 11·98d. in 1899, 11·86d. in 1900, and 11·22d. in 1901. On the Blackburn length of the Blackburn to Darwen joint system the returns for the three years are:—1899, passengers, 1,191,819; receipts, £6,446 9s. 9d. 1900, passengers, 1,606,014; receipts, £6,904 16s. 6d. 1901, passengers, 1,888,181; receipts, £8,790 19s. 9d. Receipts per car-mile, 1s. 0·21d.

Bradford.—The bad weather has so far interfered with the progress of the work of laying the cables for the tramway routes which the Corporation will take over from the tramway company on the first of next month, that the company have been asked to tender for the letting of their old rolling stock to the Corporation so that the horse and steam traffic may be continued until the conversion of the lines has been completed.

Cardiff.—Major Druitt has held a B. of T. inquiry at the Town Hall for sanction to borrow £50,000 for tramway purposes.

Central London Railway.—The proposed extension of the Central London Railway, plans of which are to be laid before Parliament next session, involves the construction of 8 miles of "tubes" running east and west by way of the Strand, Piccadilly, and Knightsbridge, and connecting at each end with the present termini. The capital expenditure necessary for the extension is put down at 3½ millions. There are to be 16 new stations, as follows:—Liverpool Street, St. Mary Axe, Bank (lower level), Cannon Street, Ludgate Circus, Temple Bar, Charing Cross, Piccadilly Circus, Green Park (Devonshire House), Hyde Park Corner, Knightsbridge, Kensington Gore, Kensington High Street, Addison Road, Hammersmith Broadway, Goldhawk Road. It is proposed that the fare for "the round" shall remain the same as at present—2d.

Carshalton.—The U.D.C. have decided to consent to the Bill of the B.E.T. Company, subject to a number of safeguards, of which the following are the most important:—

1. The company to widen, drain and make up roads as scheduled.
2. All plans to be approved by the Council.
3. The Company to use wood-paving opposite places of worship and at a few other specified places.
4. Overhead equipment to be approved by the Council and, where possible, centre standards to be used.
5. The Council to have the option of fixing lamps to the standards.
6. The company to purchase certain property, as scheduled, for widenings.
7. The company to obtain powers to effect certain alternative and preferential widenings at points east of property belonging to the Wandsworth Poor Trustees.
8. The company to indemnify the Council in respect of any loss incurred by the withdrawal of the County Council grants for highways.
9. The agreement to be without prejudice to the Council's right to petition against the Bill pending completion of the agreement.
10. Differences of views as to 1, 2, 4 and 5 to be submitted to the Board of Trade.

The estimated total cost of the tramways is £280,196.

Chadderton.—The completion of the electric tramways in Chadderton is being pushed on with by the B.E.T. Company, and in all probability cars will be running by next April.

Darlaston.—The U.D.C. have considered plans prepared by the South Staffordshire Tramways (Lessee) Company, Limited, for the line from the Bullstake, Darlaston, to Moxley, to be electrically equipped, and have decided that the work be carried out as expeditiously as possible.

Dundee.—The T.C. has decided to send a deputation to English towns to inquire into the practicability of electric traction on steep gradients. This is in connection with the Constitution Road section.

Electric Carriages.—The proprietors of the Carlton Hotel have inaugurated a day and night electric carriage service for the convenience of visitors. There are three landaulettes, capable of carrying four people; others of a larger size are in contemplation. The charges for the hire of these vehicles are the same as for a horse carriage. All the carriages are supplied with a battery sufficient for a drive of from 35 to 40 miles without recharging. The City and Suburban Electric Carriage Company, of Denman Street, have built the carriages.

Exeter.—Correspondence has passed between a Westminster firm and the town clerk, in which it was claimed that the Electric Tramways Construction and Maintenance Company, Limited, had a contract for the purchase of the existing tramways and the undertaking, and that some litigation was proceeding with the vendors owing to their being unable to deliver a proper title. The Electric Traction Committee resolved that it was desirable that information be obtained as to the practicability and suitability of introducing motor 'buses, electric road cars, and other means of passenger transit in the city, and that a deputation visit towns where any or either of these systems are in operation, and report.

Hamburg.—A scheme has been submitted for the approval of the Hamburg Senate to authorise the construction of a city and suburban electric railway of a total length of 14 miles. In the case of previous proposals of a somewhat similar character, it was only intended to touch the boundaries of the inner city of Hamburg, whereas the present project contemplates the building of a railway right into the heart of the commercial quarter and the connection of the harbour with the Stock Exchange and the chief railway station, which is now in course of construction. The railway, which will form a closed circle, will lead from St. Pauli, on the Elbe, to the Baumwall, and proceeds towards the inner town and past the Stock Exchange to the railway station; it will traverse the suburbs of Eilbeck, Barmbeck, Winterhude, and Eppendorf, and then return to the harbour. It is proposed to construct the railway partly as a high level line carried on iron viaducts and partly as an underground railway according to the practice followed in the case of the Franz Josephs Railway in Buda-Pesth and the city electric railway in Berlin, the subterranean section being projected for those parts of the inner city where the traffic on the street surface is heavily congested. The Siemens & Halske Company, of Berlin, and the Allgemeine Elektricitäts Gesellschaft of the same city, which have both been interested in electric tramway schemes in Hamburg since 1895, were induced to enter into negotiations with the Hamburg Tramway Company some time ago with a view to the elaboration of a scheme for the improvement of the transport facilities in that town, and the result of their joint labours is the formulation of the present project, for which a provisional concession has been granted to the three companies as the founders of the Hamburg City and Suburban Railway Company, which is to be constituted to take over the undertaking. It is considered that in the event of the railway having been thrown open to competition, only two schemes would have been submitted; one of these would have taken the same form as an earlier project, whilst the other would have suggested a suspended railway which would be unsuitable to the conditions prevailing in Hamburg. The

provisional agreement with the Senate provides for the granting to the City and Suburban Railway Company of a concession for a period of 90 years, during which time the State land required by the company will be placed at its disposal free of charge. In addition to this, other sites will have to be acquired by agreement at a cost of about £350,000, of which £75,000 will be contributed by the existing tramway company, which will benefit by the street improvements necessary for the purpose of the railway, whilst a new street will have to be made from the Rathhaus, in the direction of the chief railway station. The Senate will make a contribution of £200,000 for the acquisition of property for the new street, and will also pay £42,500 for the formation of the thoroughfare. The capital of the company will amount to £750,000, and it is authorised to raise a loan amounting to two-thirds of the expenditure on the works of construction and completion of the railway, which is estimated to cost £1,500,000. It is interesting to note that the interest and redemption of the loan, which will have to be paid off in 85 years, will be guaranteed by the State in so far as the surplus of income over expenditure might be insufficient for the purpose. As the interest is calculated at the rate of 4 per cent., the liability of the Hamburg State in the event of the railway being unremunerative would amount to about £62,500 per annum, but there is little probability of this money being requisitioned. Another important matter in connection with the railway is the fact that the State will assume responsibilites from which it has hitherto been free in regard to the existing tramway company. It will undertake the right of purchasing the company's tramway system at the expiration of the concession in 1922 on the basis of the payment of the capital expenditure incurred less the sum appropriated during the currency of the agreement to the purposes of redemption. As the company is only under the obligation to redeem its capital at the rate of one-seventh of 1 per cent. per annum, it will be obvious that it has made an excellent arrangement for itself even in case the concession is not renewed in 20 years hence. In return for the State taking up this obligation the company undertakes to provide all the capital of the new Hamburg City and Suburban Railway Company. It is proposed to complete the railway in five years, and after the payment of a dividend at the rate of 5 per cent. on the share capital, the State will participate in the balance of profit to the extent of being repaid the interest on the capital advanced for the acquisition of ground property for the purpose of the railway. On the expiration of the concession, in 90 years, it will be possible for the State to purchase the railway on the payment of 25 times the amount of the average net proceeds of the last five years, or a sum at least equal to the amount of the total share capital of the company.

Isleworth.—The U.D.C., at a special meeting, declined the offer of the L.U.T. to pay £1,000 towards the cost of widening Twickenham Road, but instructed the Works Committee to enter into further negotiations with the company with a view to a mutual understanding.

Leicester.—The T.C. has formally taken over the management of the tramways undertaking from the old company.

London—Brighton Electric Railway.—The *Financial Times*, in a summary of the proposal, says that the promoters of the Bill for incorporating the London and Brighton Electric Railway Company have duly deposited their Bill for introduction into Parliament next session. The Bill proposes to confer powers on the company to construct a practically straight line of railway, 45 miles in length, from a point at 37, Ranelagh Road, Pimlico, to St. Mary's Home, in Queen's Square, Brighton. The generating station will be erected at Worth. The promoters of the scheme include Sir Henry Knight, Sir William Treloar, Mr. Francis Barnes, J.P., and Mr. Harding Cox, who, with three others, will be the first directors. The share and loan capital is fixed at £12,000,000, of which £9,000,000 will be raised by the issue of 900,000 £10 shares, and £3,000,000 by the creation of debenture stock. The time sought within which to complete the railway is five years from the passing of the Act, but all powers for the compulsory purchase of lands are to cease after the expiration of three years from the same period. During the time required for construction the company asks for power to pay interest to shareholders out of capital, provided that the aggregate amount so paid for interest shall not exceed £900,000. The maximum fares to be charged are the usual mileage rates of 1d., 2d. and 3d. per mile for third, second and first-class passengers respectively.

At the last meeting of the Brighton T.C., the General Purposes Committee recommended that the town clerk should take all necessary steps to oppose the London and Brighton Electric Railway Bill in Parliament with a view of obtaining the insertion therein of clauses necessary for the protection of the interests of the Corporation, and that it should be authorised to retain agents, counsel and witnesses for the purpose. Councillor F. Blaker wished to remove an impression that had gained ground among the ratepayers that the Council were hostile to the scheme. There was not one solitary member of the Committee who was opposed to the proposal, but it was thought wise to oppose the Bill in order to safeguard the interests of Brighton. In reply to a question, it was pointed out that the Council were obliged to oppose the Bill in order to secure a *locus standi* in the committee room of the House of Commons. The chairman's recommendation was adopted.

Manchester.—The estimate of the cost of constructing the proposed tube railway has been lodged in Parliament by Messrs. W. Percy Justyne and W. A. Jackson, the engineers. The line is to be 2 miles 4 furlongs 4·32 chains in length, and tunnelling works will cost £420,000. Stations are put down at £150,000, and land and buildings to be acquired at £429,921. Permanent way, sidings, junctions, culverts, &c., are expected to cost another £24,000, and 15 per cent. extra for contingencies brings up the total to £1,112,763.

North to South Shields Electric Railway.—A Bill to improve the facilities for communication across the River Tyne between North and South Shields has been deposited for next session in the Private Bill Office of the House of Commons. Under this Bill, says the *Financial Times*, it is proposed to incorporate the North and South Shields Electric Railway Company with powers to construct a railway over 6 furlongs in length under the River Tyne, from a point in Tynemouth near the intersection of Bedford Street and Wellington Street to Stanhope Street in South Shields. The railway is to be constructed in a single tunnel with a diameter of 13 ft. between the stations and 30 ft. at the stations, and is to be worked by electrical power supplied from a generating station to be erected in South Shields. The capital of the company is proposed to be £180,000, in 18,000 £10 shares, with power to divide them into preferred and deferred half shares. Upon this capital it is proposed to raise £60,000 by the issue of debenture stock. The time sought for the construction of the railway is five years from the passing of the Act, and, in order to facilitate the raising of the necessary capital, it is proposed to expend £16,200 in the payment of interest out of capital during the period of construction. The rates for passengers are to be 2d. per single journey first class and 1d. second class. The promoters of the scheme, who are named in the Bill, are Mr. Emile Garcke, Mr. Joseph Robinson, Mr. Roland Philipson, Mr. John Robert Hogg, Mr. Stephen Lamb Robson, Mr. John Martin Winter, Mr. William John Bone, Mr. Frederick Rennoldson, Mr. William McLellan and Mr. James Frazer. The first directors will be Mr. Joseph Robinson, Mr. Roland Philipson, Mr. William John Bone and Mr. Frederick Rennoldson, and three others.

Russia.—It is stated that a powerful American syndicate has obtained from the Russian Government numerous electric tramway concessions in St. Petersburg, Moscow, and several smaller cities in Russia. The value of the concessions is put down at the fancy figure of 40 millions sterling, and the English and American Westinghouse Companies are stated to be largely interested as manufacturers of the equipments for the different undertakings.

St. Helens.—A proposal of the Committee that the tramways company should be permitted to carry goods over the tramways at a rate of 2d. for every car, laden or empty, passing through the borough, and 1d. for every car passing from point to point within the borough, gave rise to a long discussion at the Council meeting last week. All of the councillors but one, Alderman Beecham, were opposed to the terms suggested, and considered that much higher rates should be required from the company. Col. Pilkington thought that the charges ought to be 6d. or 1s. Councillor Foote proposed that the minutes in regard to the matter be referred back. Councillor Houghton seconded. Speaking upon this proposal, Alderman Beecham, chairman of the Electric Supply Committee, thought that, instead of putting an impediment in the way of the tramways company, the Council ought to make the charge as low as possible. The company would have to pay 1½d. per unit up to a million units, and 1d. per unit after. At present they paid 1d. on 800,000 units. If the Corporation found, at the end of 2½ years, that 2d. and 1d. did not pay, they could increase the rates. The minutes were confirmed, with the exception of those relating to the proposed arrangement with the company. The subject will have to be discussed by the Joint Committee.

Salford.—A new route was opened on Saturday last when electric trams ran between Blackfriars Bridge and Kersal to the Prestwich boundary. This will be a convenience for the residents of Higher Broughton and Kersal.

Sheffield.—One of the overhead trolley wires fell on 5th inst. A horse was killed.

Simplon Tunnel.—The *Times* Paris correspondent reports that the Simplon Tunnel is making satisfactory progress. Half of it, or a length of six miles, has now been bored. The Swiss section is rather more forward than the Italian. Whereas the Mont Cenis was bored by machinery and the Gothard by dynamite, the Simplon is being bored by a continuous rotary movement, which under hydraulic pressure is extraordinarily powerful. This system has been devised by Herr Brand, the Hamburg engineer, one of the two contractors. The tunnel is to be completed by May, 1904, and there is no fear of any delay.

Sunderland and South Shields.—The Tramways Committee of the Sunderland Corporation have received notice from the B.E.T. Company of their intention to apply for Parliamentary powers for the construction of tramways from South Shields to Sunderland, and the town clerk has been instructed to give notice of dissent to any proposal to construct lines in the borough of Sunderland. Our correspondent understands that the South Shields Council are going to memorialise against the Bill on the grounds that certain standing orders have not been complied with by the company.

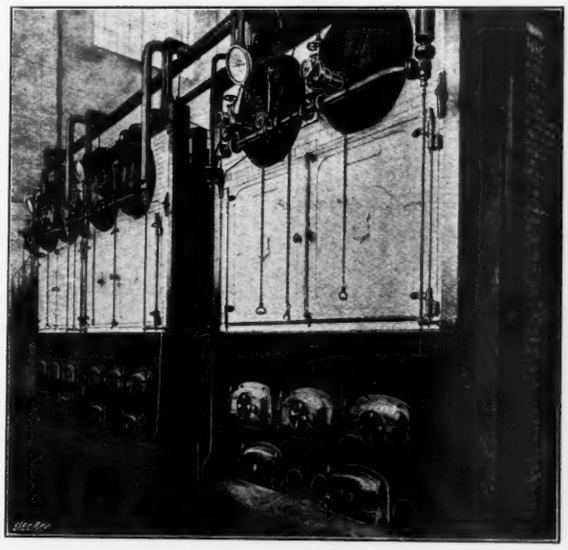
(*Continued on page* 63.)

PORTSMOUTH ELECTRIC TRAMWAYS.

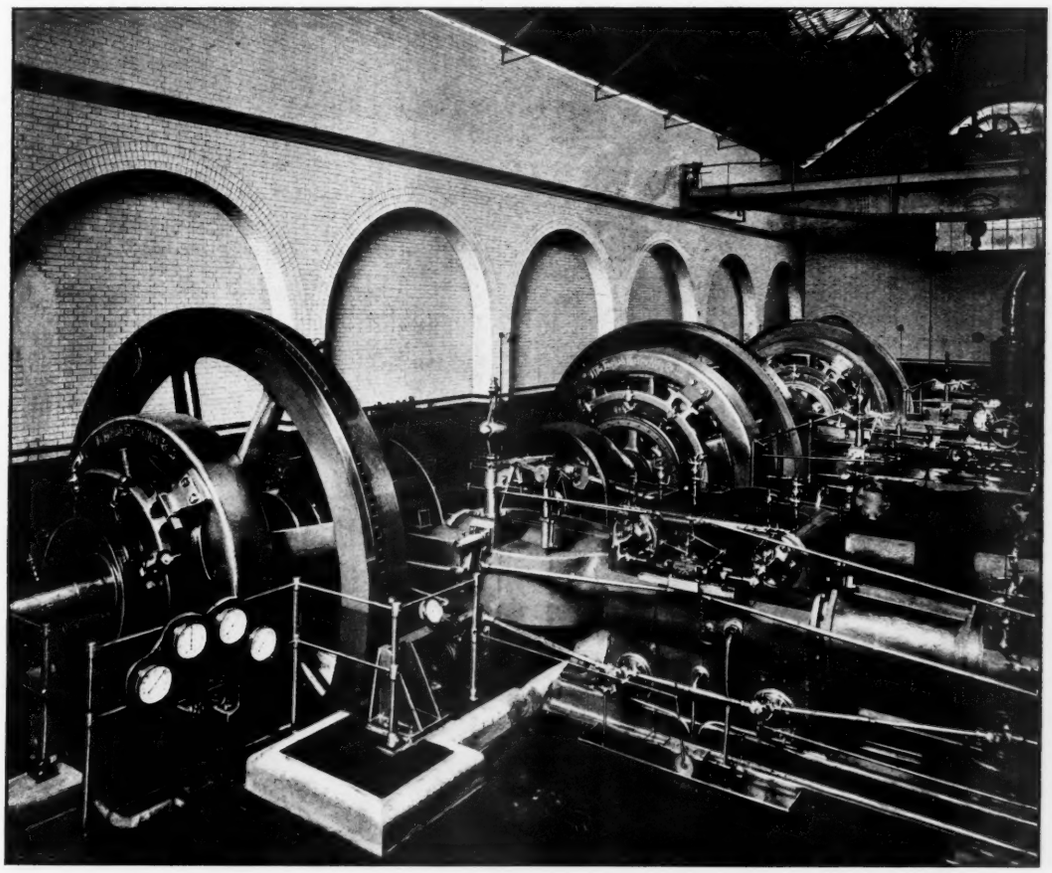
For some years the Portsmouth tramways were owned and operated by a company, whose lease recently expired. The Corporation, however, instead of renewing the lease, took steps to acquire the undertaking by compulsory purchase, and obtained an Act of Parliament for that purpose in 1898; the Act also provided for considerable extensions of the system. The negotiations with the company were long and arduous, and eventually the matter was referred to arbitration; the purchase price, together with the costs, amounted to about £200,000.

Mr. E. Rotter, who was appointed engineer and manager to the tramways in September, 1899, had in the meantime drawn up the specifications and plans, and the contracts for carrying out the work were let in the autumn of 1900. Messrs. Dick, Kerr & Co. received the contract for the whole of the generating plant, permanent way and cables, while the overhead equipment was placed in the hands of Messrs. Macartney, McElroy & Co. In this connection it is worthy of remark that practically the whole of the work was carried out by British manufacturers, including the generators and car equipments. The power station plant cost about £30,000; the reconstruction of the permanent way involved an expenditure of over £200,000, and the rolling stock came to about £50,000. The tramways were taken over at the beginning of 1901, and for a time were operated with horses, but the reconstruction of the lines was commenced in February of that year.

The overhead trolley system was adopted, and the lines were carried through the principal streets to the boundaries of the borough. One route extends beyond this limit for some distance, and will eventually join the Cosham and Horndean Light Railway. The district is fairly easy, so far as regards gradients, which are infrequent, and not of a severe character. The curves, however, are very numerous and of sharp curvature—the smallest radius being 35 ft. Various street improvements were carried out in the course of



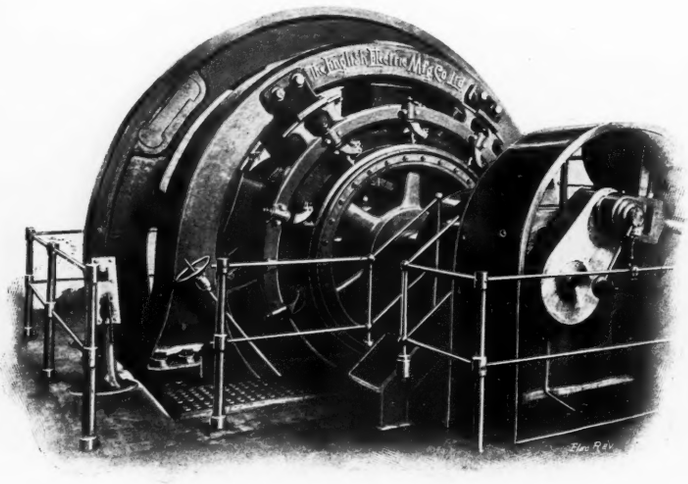
Water-Tube Boilers.



General View of Engine Room.

the work, and the roadway under two railway bridges had to be lowered to give the necessary head-room.

The power station is shown in cross-sectional plan and elevation in our figures on p. 62, from which it will be seen that the boiler house and engine room are arranged side by side,



View of Traction Generator.

with a chimney at one end. The steam-raising plant consists of three Babcock and Wilcox hand-fired water-tube boilers, each capable of evaporating under normal conditions 12,000 lbs. of water per hour, at a pressure of 160 lbs. per sq. in. Each boiler is fitted with a superheater designed to give a superheat of 100° to 120° F., and the usual mountings. A Green economiser of 192 tubes is also provided, the scrapers of which are driven by a 500-volt Lundell motor. There are two feed pumps, one rated at 24,000, and the other at 12,000 lbs. of water per hour, against the boiler pressure; they are of the double-acting type, and the valve gear of the steam cylinders is so designed that the pump takes the full length of stroke at all speeds.

A coal store is provided, and is equipped with a light tramline running into the boiler house, passing over a weighing platform on the way. The coal is brought to the works in carts.

The arrangement of the steam pipes is of a very simple character; a main range runs along the engine room wall, and is connected with each boiler and engine by a single branch, while stop valves are provided at intervals, so as to isolate any section at will. The steam pipes are of lap-welded mild steel, with wrought-steel flanges, and the short bends are of solid drawn copper, with gun-metal flanges. The exhaust pipes are of cast-iron and are led under the floor to the main exhaust pipe and the condensers. The latter are of the Worthington "Admiralty" surface condensing type, one for each engine; two of them are each capable of condensing 12,000 lbs. of steam per hour, while the smaller one is rated at 6,000 lbs. per hour. The outer shells are of cast-iron, and the tubes of solid drawn brass.

The condensers are used in conjunction with a cooling tower, of which we give a view; this is built in two sections, each of sufficient capacity to provide cooled water for one of the large condensers. The tower is constructed of steel plates, and is fitted with two fans forcing air in at the bottom; these are driven by electric motors installed in a motor room.

There are three sets of combined air and circulating pumps, with compound steam cylinders, a separate set being provided for each condenser. The circulating pumps are capable of drawing water from the storage tank under the cooling tower and forcing it to the top of the latter. Provision has been made for adding a third section to the cooling tower when it is required.

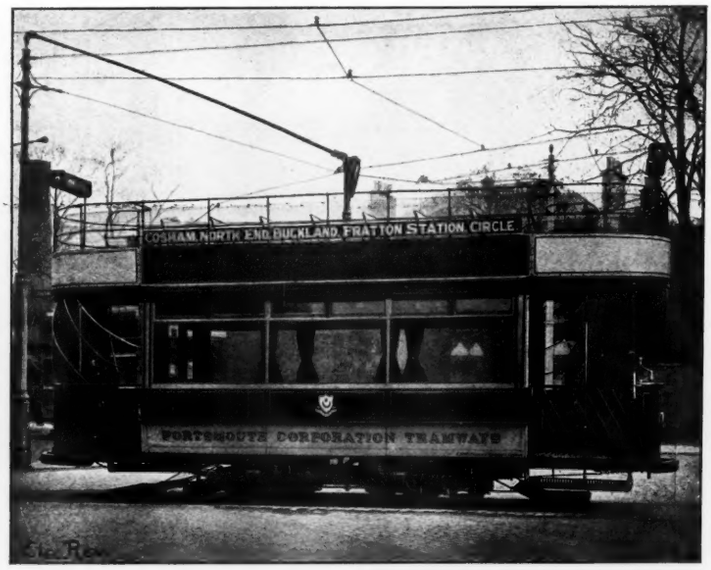
The generating plant consists of three low-speed horizontal engines coupled to traction generators, two of 400 KW. each and one of 200 KW. The engines were made by Messrs. Yates & Thom, of Blackburn.

Two of them are of the horizontal cross-compound type, with Corliss valve gear, each developing 640 I.H.P. under normal conditions and at the most economical load, and 900 I.H.P. at their maximum load when running at a speed of 90 to 100 revolutions per minute and with a pressure at the stop valve of 150 lbs. per sq. in., working condensing. The third engine is of the horizontal tandem compound type, with Corliss valve gear, and develops 320 I.H.P. under normal conditions, with an overload capacity of 450 I.H.P. under the same conditions as the larger machines.

In the two larger sizes the diameter of the high-pressure cylinder is 18 in., low-pressure 36 in., stroke 42 in., diameter of piston rods $4\frac{1}{4}$ in., diameter of crankshaft $17\frac{1}{2}$ in., and diameter and length of main journals 14 × 26 in. The fly-wheel of each of the large sets is 18 ft. in diameter, and weighs approximately 25 tons.

The diameter of the high-pressure cylinder in the smaller engine is 15 in., and of the low-pressure 30 in., the stroke being 36 in.; the diameter of the fly-wheel is 16 ft., and its weight approximately 22 tons.

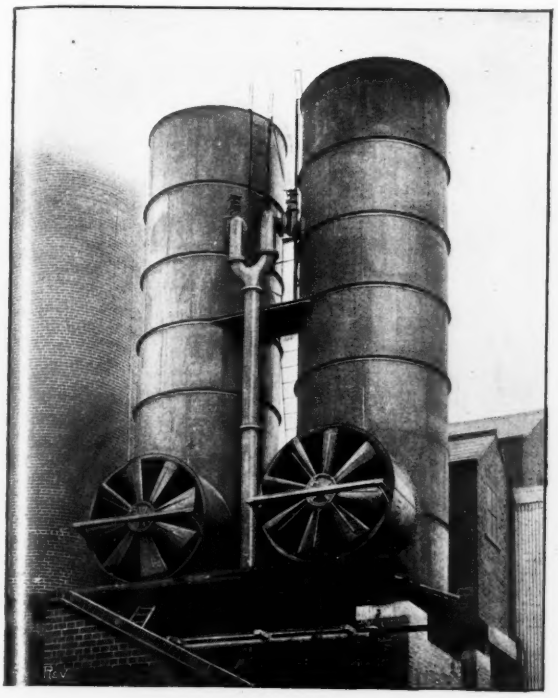
The cylinders are of hard, close-grained cast-iron, and both high and low pressure cylinders are steam jacketed. The valves of both cylinders are provided with automatic variable cut-off gear, actuated directly by the governor, provision also being made for adjustment by hand. The crankshaft is of forged Siemens-Martins steel, and is swelled



View of Car.

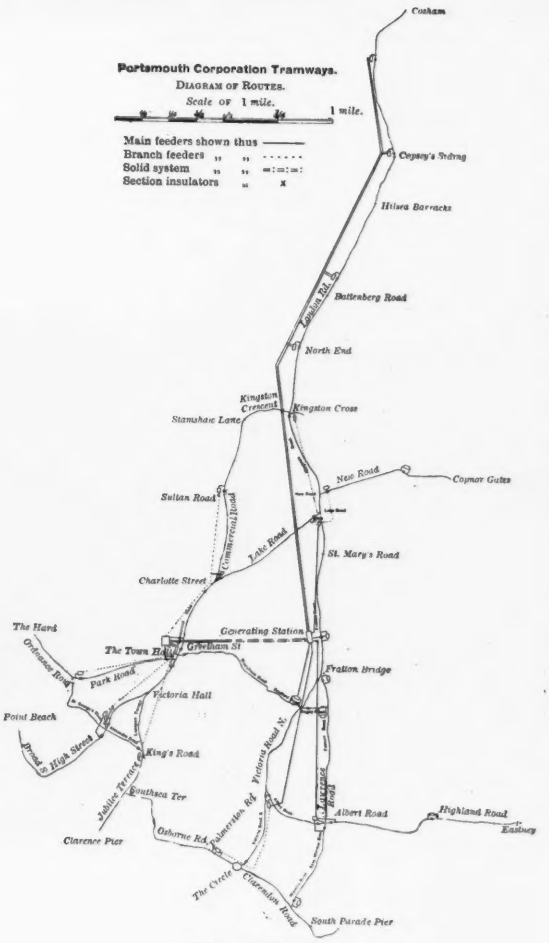
at the middle to receive the fly-wheel and the generator armature.

The fly-wheel boss is provided with a flange for coupling



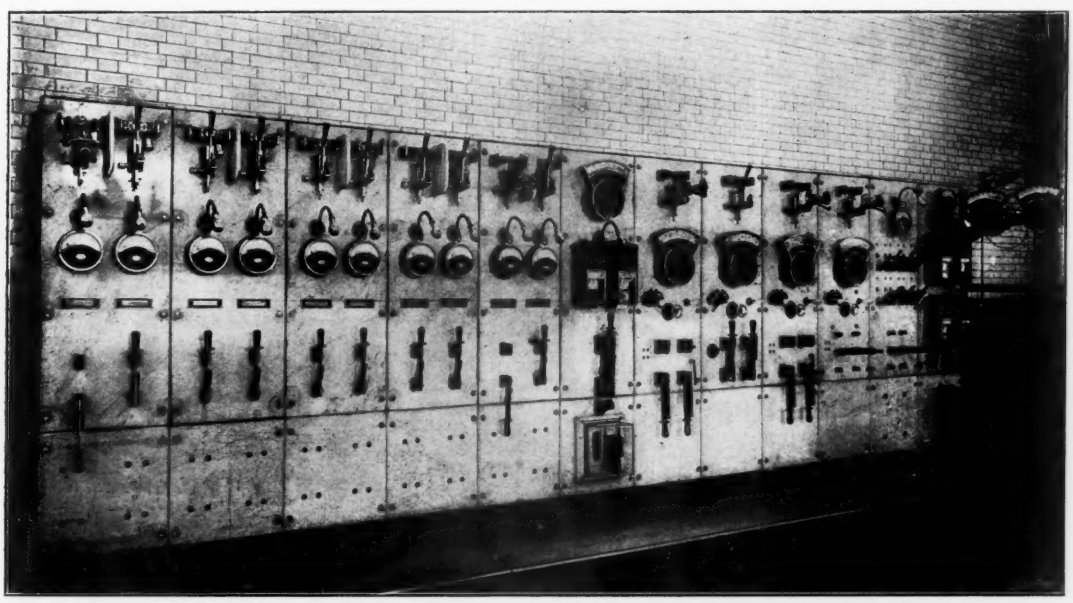
Cooling Tower.

to a corresponding flange on the spider of the generator armature, so as to take the heavy, sudden strains of overload off the shaft and keys. There is a complete system of automatic lubrication provided throughout the engine. It is specified that the permanent speed variation shall not exceed 2 per cent. from the mean speed when the load is varied



Map of Routes.

The generators are of the type generally supplied by Messrs. Dick, Kerr & Co., and were manufactured by the English Electric Manufacturing Company, with whom they

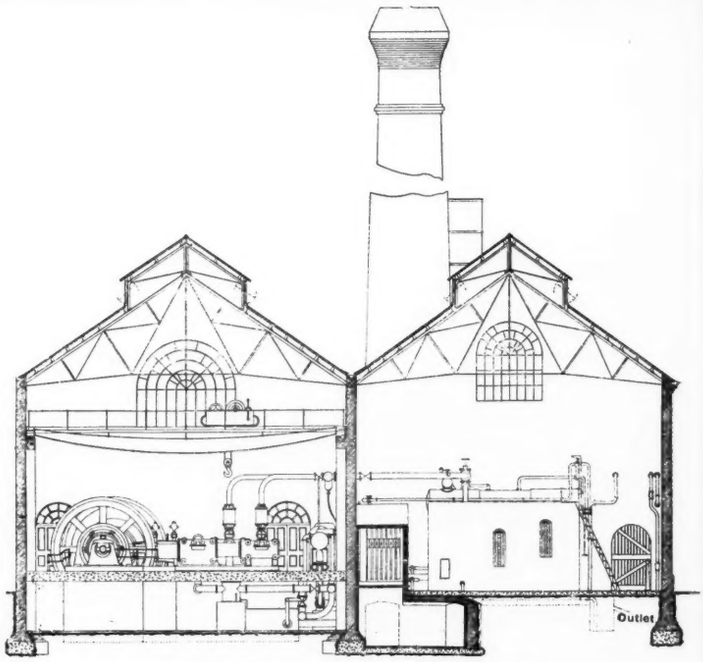


Main Switchboard.

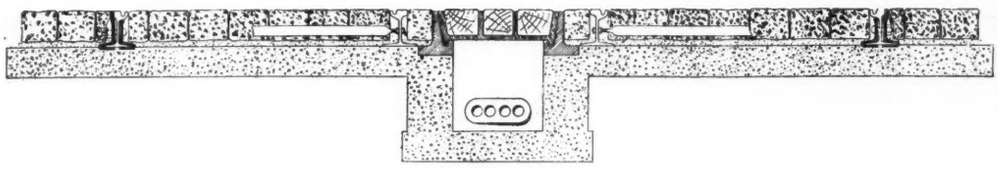
under ordinary working conditions, and the greatest variation under extreme temporary load conditions is not to exceed 5 per cent. from the mean.

are associated. The three generators are of the multipolar compound wound type, and the compounding is such that the voltage at no load is 500, rising to 550 volts at full

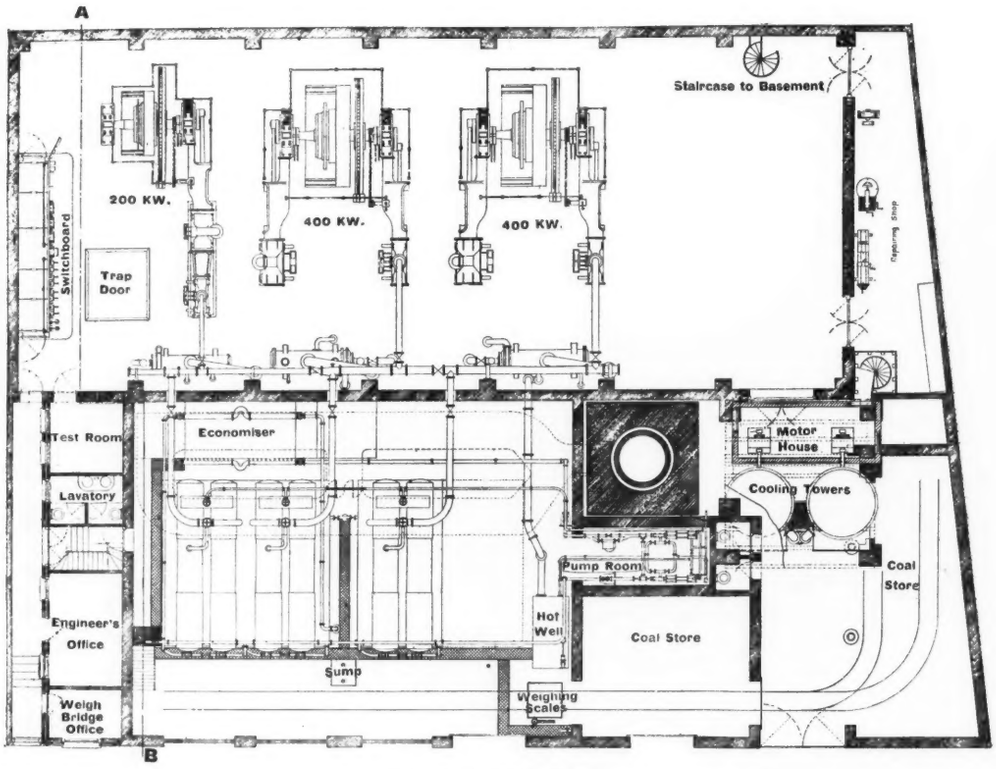
load. Each dynamo is capable of carrying its full load for 24 hours, an overload of 25 per cent. for 1 hour, and 50 per cent. for short periods without injurious heating or sparking. The field magnet frame consists of a circular yoke of cast-iron, built in two halves. The pole-pieces are of laminated steel, cast into the yoke. Each magnet frame is arranged for sliding along girders, sufficiently clear of the armature shaft to permit of the removal of the magnet windings without disturbing the armature. The field magnet spools are of sheet-iron with brass ends, which fit over the magnet poles; the spools are covered with an insulating lining, composed partly of mica, paper, and linen, the whole being agglomerated into a single sheet by means of shellac. The series and shunt coils are wound side by side on the spool, with an insulating layer between them, the series coil occupying the end of the spool nearest to the yoke. The armatures are of the ironclad type, with slotted core of laminated sheet-steel, built up on a cast-iron spider. The spider is built of a good quality of iron, the sections of the rim being unconnected so as to avoid all shrinkage strains. It is provided with a long bearing surface for the shaft of the engine to which it is to be fitted. It is bored accurately to a gauge supplied by the engine



Vertical Section of Power Station at A B.



Section of Track.



Plan of Power Station.

builder, and is made slightly smaller than the diameter of the shaft, so that it requires about 100 tons pressure to force it into position, after which it is secured by means of two keys. The commutator is built up on its own spider, which is carried on the hub of the armature spider, to which it is securely keyed. On the periphery of

the commutator spider the hard drawn copper commutator bars are clamped by means of steel end rims; equalising rings are attached to the commutator, thus neutralising any difference in the magnetic conditions of the various magnetic circuits.

The switchboard is of the usual traction type, and is divided into 12 marble panels, carried on vertical angle irons about 3 ft. clear of the wall. Automatic circuit breakers are provided on both generator and feeder panels; all the instruments are of the usual type, and there is a special panel provided to meet the requirements of the Board of Trade.

The construction of the permanent way was carried out with exceptional despatch. A severe frost delayed the start for a fortnight, but a commencement was made towards the end of February last year, and by the official opening at the end of September, a total length of 23½ miles of track had been completed, at the rate of nearly one mile per week. The total route length is about 14½ miles, of which 14 miles are double track and half a mile single.

The cross-section of the track is shown in one of our figures. The gauge is 4 ft. 7¾ in., and the rails, of the steel girder type, weigh 90 lbs. per yd., in lengths of 40 ft. The fishplates weigh 130 lbs. per pair, and, as will be seen from the figure, are combined with soleplates. A good deal of the track is laid interlacing. The rails are double bonded with Neptune bonds 30 in. long, and are cross-bonded every 40 yds. The foundation of the track consists of 6 in. of concrete, varying to 13 in. in places, upon which the rails are laid direct.

The overhead equipment was carried out on both the span wire and the bracket systems, much of the track being equipped with single-arm bracket poles. The trolley wire is double throughout, of No. 00 B. and S. gauge, and is placed centrally over the track. The system is divided into sections, each half a mile long, supplied with current by 14 feeders, which are for the greater part drawn into conduits.

The present rolling stock consists of 80 double-deck single-truck cars, manufactured by the Electric Railway and Tramway Carriage Works, and electrically equipped by the English Electric Manufacturing Company, both of Preston; one of them is shown in our illustration. The car bodies are constructed with the "Bellamy" reversed staircase, and the interiors are fitted in quartered oak; each car is fitted with 14 16-C.P. lamps, of which six are inside, and with illuminated route indicators.

The roof is constructed on the "Preston" pattern, which gives the maximum cubical space and improved facilities for ventilation. The trucks are of the "Brill" type, and are fitted with hand brakes and electrical emergency brakes. The controllers are of the series-parallel type, with solenoid blow-outs, and the motors are of 25 H.P. each.

The whole system of tramways has been designed by Mr. E. Rotter, and carried out under his supervision. Mr. Rotter combines the duties of engineer and manager of the tramways, which form the largest municipal system in the south of England. The speed with which the work was done, and the satisfactory results which have already been obtained, reflect great credit upon both the engineer and the contractors; and having regard to the importance of the town and its heavy internal and external traffic, there is every prospect of the undertaking proving a financial as well as an engineering success.

Set a Thief to Catch a Thief.—As an instance of the perfect trust and reliance which municipal authorities repose in one another, the resolution of the Somerset County Council to keep a jealous eye on the Bristol Corporation's doings in respect of neighbouring parishes, which is recorded elsewhere in this issue, is worth noting. The County Council fears that the City Council will exploit the little townships for the benefit of its ratepayers—just as if, forsooth, the Corporation were no better than a great, greedy, grind-the-face-of-the-poor trading company! It is well to remember that this term—a "trading company"—is exactly what Sir Courtenay Boyle applied to a corporation under these conditions. But what a concern—a company with unlimited liability, controlled by a board of directors innocent of expert knowledge of the trade in which they are engaged, and liable to drastic changes at the whim of the shareholders!

ELECTRIC TRACTION NOTES.

(*Continued from page* 58.)

Wallasey.—At the meeting of the D.C. last week, a report by the electrical engineer on the subject of lifeguards was considered. It was resolved that 12 cars should be fitted with the Tideswell guard. The town clerk stated that the Board of Trade had sanctioned the use of the Tideswell guard on the new electric cars.

Wigan.—At a meeting of the Wigan Electric Light and Tramways Committee on Monday, at which Mr. R. Johnson presided, the Committee decided to purchase the undertaking of the Tramways Company on the terms stated in the letter, and that application should be made to borrow £10,600 with which to obtain a supply of motors. The Committee also decided to proceed with the construction of the tramway line along Library Street. Mr. J. Slevin was appointed manager and Mr. W. Dewse secretary of the tramways undertaking.

Yarmouth.—The T.C. has decided, by a large majority, that the Corporation will work its own trams. Particulars of the British Electric Traction Company's tender were given in the ELECTRICAL REVIEW of the 20th ult. The town clerk read a letter from the company, increasing their offer to £100 per route-mile instead of £75, and respecting the purchase of electric energy, the company would be prepared to guarantee a minimum payment of £2,000 per annum, and with respect to the percentage of gross receipts, the company would guarantee an annual payment of £1,000 as a minimum. The net result of the company's increased terms would be approximately £1,000 per year more.

TELEGRAPH AND TELEPHONE NOTES.

Birkdale Telephones.—The Birkdale District Council have completed their arrangements with the National Telephone Company for placing the telephone wires in the district underground. A system of intercommunication with the Southport Municipal Telephone Exchange will, it is said, when the latter scheme assumes definite shape, smooth all difficulties of working. The Council have agreed to carry out the work of laying and jointing the underground telephone pipes and constructing the manholes to the satisfaction, and in accordance with the direction, of the company's representatives at the company's expense.

Canadian Telegraph Projects.—The daily papers announce that Sir Sandford Fleming, in a letter to Mr. Mulock, the Dominion Postmaster-General, advocates the construction of a State-owned Atlantic cable and landlines through Canada, or a Marconi system if wireless telegraphy is developed. He estimates the revenue of a cable at £40,000 a year, and the cost at £33,000, with a rate for messages of 1d. per word.

Folkestone Telephones.—The Folkestone Council has approached the Dover authorities with a view to their co-operation in the movement for rendering the whole district independent of the National Telephone Company.

Halifax Telephones.—The Finance Committee has determined to apply for a municipal telephone licence. Mr. Lord, the borough engineer, has presented to the committee the following estimates of cost of establishment and management:—Mr. Lord recommends that a central exchange be erected at a cost of £1,000; he estimates the cost of fitting up at £500; three switchboards for local service, £1,200; one trunk-board, £300; a test-board and cross connecting-board (including all the latest devices), £380; switch-cable, £70; connecting cables, with storage battery, &c., £250; 500 instruments, £1,750; laying of underground cables, distributing wires, &c. (including way-leaves), £8,000; total estimated cost, £13,450. The annual cost of management and supervision is put down at £1,212, and of maintenance at £300.

Hastings Telephones.—Mr. Bennett appeared before the Hastings Telephone Committee last week, to advise them regarding a municipal telephone service. For selling their local system to the Council the National Telephone Company asked a price calculated at 4 per cent. on the capital expended, multiplied by 20 years. Mr. Bennett is to prepare a report.

Paris—Turin Telephone.—A telephone line between Turin and Paris was opened to the public on New Year's Day.

Scarborough Telephones.—A sub-committee has reported on the subject of municipal telephones, and it has been decided to engage the services of Mr. Bennett to advise.

The Telegraph Service.—At a special meeting of the Council of the Liverpool Chamber of Commerce last week, the secretary reported that a direct wire had been established between Liverpool and Paris, experimentally, and that the Postmaster-General had promised to consider the suggestion by the Chamber that telegrams to Switzerland from Liverpool should be sent over

the Liverpool—Paris wire. Lord Londonderry had also intimated his intention to investigate the subject matter of the Chamber's request that a direct wire should be established between Liverpool and Emden.

Telegraphs and Telephones on the Gold Coast.—The report of Mr. C. H. Hunter, Acting Colonial Secretary, on the Blue Book of the Gold Coast for the year 1900 was published last month, December, its publication having been delayed. He states that the total number of telegrams transmitted during the year was 140,315 as compared with 128,026 in the previous year, and the revenue collected was about £400 in excess of that of 1899. Temporary offices were opened at a number of places during the Ashanti disturbances. The telegraph line for the greater part of the distance beween Prahsu and Coomassie and for many miles north of Coomassie, was destroyed by the Ashantis, but the greater part of it was restored before the end of the year. The number of messages sent through the Government offices for transmission by the African Direct Telegraph Company, amounte i to 2,563 as compared with 2,268 in 1899. In regard to telephone facilities, there is a telephone exchange at Accra connected with all the Government offices, and it was intended to establish an exchange at Cape Coast, but the disturbances in Ashanti prevented it being completed. Communication was established, however, between Cape Coast Castle, the Base Commandant's Office and the Hospital.

Telegraphic Interruptions and Repairs :—

Cables.	Interrupted.	Repaired.
Latakia-Cyprus	June 20, 1899 ..	..
Para-Maranham	March 1, 1900 ..	..
Mole St. Nicholas-Port au Prince	Dec. 28, 1901 ..	..
Landlines :—		
"*Via* Hanekin" on Persian territory	Feb. 24, 1900 ..	..
Communication with Baranquilla and Cartagena	Dec. 8, 1900 ..	..
Majunga-Tanarive	Dec. 15, 1901 ..	January 1
Cap Haitien-Port au Prince	Dec. 31, 1901 ..	January 6

Telephony in Egypt.—The *Electrical World* says that the Telephone Company of Egypt, Limited, operating a large telephone system in Egypt, has experienced great difficulty in securing a suitable pole. The climate of the country is so hot and dry that good timber to use for a pole line for the transmission of an electric current, does not grow and timber imported from other countries dry-rots and becomes useless in a very short time. A certain pole imported from Sweden proved to be of the most value so far, but its greatest life was not over four years. The company began negotiations, therefore, with cedar pole firms in the United States, with the result that arrangements have just been completed with W. C. Sterling & Son, of Monroe, Michigan, wholesale producers of cedar poles, ties and posts, for the shipment of 1,500 poles of the white cedar variety, Michigan grown, to Alexandria and Cairo, Egypt.

Wireless Telegraphy.—The Commissioners of Northern Lights have decided to adopt wireless telegraphy as a means of communication between the mainland and some of their lighthouses. The first installation, which will be made in conjunction with Lloyd's Shipping Agency, will be at the Flannan Islands, situated about 13 miles off the west coast of Lewis, which is practically the first land sighted by vessels from America. The Marconi system will be used.

Captain J. E. Bernier, a Canadian explorer, is organizing an expedition to the North Pole. The members of the party after they leave their ship will remain in wireless telegraphic communication with it.

The *Times* New York correspondent reports that cable securities are suffering upon a report that Signor Marconi intends to adopt a wireless relay station by a vessel stationed in mid-ocean.

CONTRACTS OPEN AND CLOSED.

OPEN.

Barking Town.—January 24th. Additional generating plant for the Council's electricity works. See "Official Notices" December 20th.

Barnstaple.—January 16th. Boilers, engines, dynamos, mains, &c., for the Town Council. See "Official Notices" December 13th.

Belfast.—January 17th. Cables, roadwork, conduits, &c., for the Electrical Committee. See "Official Notices" January 3rd.

Belgium.—February 15th. Proposals are being invited by the municipal authorities of Lourain for the lighting of the public streets by electricity or gas.

Belgium.—March 1st. The municipal authorities of Ghent are inviting tenders until the March 1st, 1902, for the concession for an electric lighting installation. See our "Official Notices" January 3rd.

Cardiff.—January 22nd. Two 1,600-I.H.P. vertical engines, and two 900-KW. generators for the Tramways Committee. See "Official Notices" to-day.

Egypt.—January 18th. Electric lighting of Suez and Damanhour. Particulars from the Minister of Public Works, Cairo.

Fulham.—January 27th. Twenty 50-KW. transformers, mains, conduits, lamp-posts and street boxes. See "Official Notices" to-day.

Glasgow.—January 17th. Overhead tramway equipment (material, poles and fittings), for the Corporation. See "Official Notices" to-day.

Grimsby.—January 20th. Steam dynamos, switchboard extensions, battery, condenser, piping, water-tube boiler for electricity works. See "Official Notices" December 27th.

Hartlepool.—January 25th. Buildings, marine boilers, engines and dynamos, battery, switchboard, arc lamps, columns, mains, and cranes, for electricity supply works for the Corporation. See "Official Notices" January 3rd.

Hornsey.—January 15th. Pipework and mechanical coal-handling plant for electricity works for the U.D.C. See "Official Notices" December 6th.

Hunslet.—January 21st. Electrical equipment of the new workhouse and infirmary at Bothwell Haigh for the Guardians. See "Official Notices" January 3rd.

Ilford.—January 27th. Rail-bonds, conduits, drawboxes, &c., for the U.D.C. tramways. See "Official Notices" to-day.

Lancaster.—January 23rd. 200 and 300 KW. steam dynamos, boilers, switchboard and crane, for the Corporation. See "Official Notices" to-day.

L.C.C.—January 14th. Electric wiring and fittings for the Council's new Farmfield Reformatory near Horley. See "Official Notices" January 3rd.

L.C.C.—January 28th. The L.C.C. is in the market for about 3,250 tons of track rails; 1,850 tons of slot rails; 670 tons of conductor tee rails; fishplates, bolts, nuts, &c., required in connection with the reconstruction of tramways for electric traction. Specifications, &c., at the County Hall, Spring Gardens, S.W., upon payment of £2.

Leeds. — January 16th. Surface condensing plant (2,000 B.H.P.) for the electric lighting department. See "Official Notices" January 3rd.

Manchester.—January 18th. The Tramways Committee wants tenders for the supply of overhead equipment, tools, &c.

Manchester.—January 21st. Three-phase switchboards, exciter and auxiliary ditto, three-phase boards for sub-stations, low tension boards at sub-stations at the Stuart Street generating station. See "Official Notices" December 20th.

Middlesbrough.—January 21st. 300-KW. engine and dynamo, switchboard panels, ejector condenser, feed pump and economiser for the electricity works. See "Official Notices" December 20th.

Middleton.—January 16th. Wiring the Town Hall. Mr. S. Pauls, borough electrical engineer.

Paisley. — January 13th. Steam engines, dyamos, switchboards, and condensers, for electric tramway station. See "Official Notices" January 3rd.

Poplar.—January 11th. Electric lighting of the Town Hall, and Bow and Bromley Vestry Halls. See "Official Notices" January 3rd.

Rockhampton (Australia).—March 31st. We read in the *Contract Journal* that the Council of the Municipality of Rockhampton is prepared to consider applications from companies desirous of undertaking the construction and working of a system of electric tramways under the Queensland Tramways Act of 1882, and the Amendment Act of 1890. Rockhampton with a population of 15,461, is a rising town, and is situated on the Fitzroy River, about 40 miles from the sea coast, and is the second largest town in Queensland. Particulars of construction, maintenance, and working of tramways are contained in the Queensland Tramways Act of 1882, and the Amendment Act of 1890, copies of which may be seen at the office of our contemporary. Applications to be forwarded to Mr. H. W. Johnson, Mayor, Municipal Chambers, Rockhampton, Queensland, Australia, by March 31st.

St. Pancras.—January 17th. Engines, dynamos, condensers, piping, boilers, pumps, &c., for the Borough Council. See "Official Notices" January 3rd.

South Lancashire.—January 29th. Two-phase motor-generators, boosters, and batteries for the S.L.E.T. and Power Company. See "Official Notices" to-day.

Spain.—January 27th. Tenders are being invited by the Spanish Ministry of Public Works in Madrid until the 27th inst., for the concession for the construction and working of an electric tramway between Tolosa and San Sebastian (Guipuzcoa province). Tenders are to be sent to El Ministerio de Obras Publicas, Madrid, whence particulars may be obtained.

West Bromwich.—January 17th. Rails, points, crossings, drain rails, road work, bonding, trolley poles, overhead line work, section boxes, cables, &c., for electric tramways for the Council. See "Official Notices" December 20th.

West Bromwich.—January 29th. Boilers, dynamos, booster, switchboards, condenser, &c. See "Official Notices" today.

West Ham.—January 14th. Surface condensing plant and travelling crane for the electricity works. See "Official Notices" December 13th.

CLOSED.

Batley.—The Corporation has accepted the tender of Messrs. Clayton, Son & Co., Limited, of Hunslet, for boilers, steam pipes, &c., for the electricity generating station.

Dublin.—The St. Helens Cable Company has received the Dublin Tramway Company's contract for packing, mats, &c., for 1902.

Great Northern and City Railway.—The Desrumaux Water Softening Company, of 5, Queen Victoria Street, London, have received from the British Thomson-Houston Company, a contract for the water softening apparatus required in connection with the Great Northern and City Railway scheme. The plant is to treat 8,500 gallons per hour of Regent's Canal water and to be erected at the new generating station at Poole Street, New North Road, London. The British Thomson-Houston Company have also placed with the Desrumaux Company a further order for water softening apparatus for the Chatham Tramways scheme.

Manchester.—Messrs. C. H. Normanton & Son asked the Electricity Committee to relieve them of one of their two contracts for the construction of subways from the Stuart Street generating station to Ashton New Road. They found that they can only complete one of these contracts in the time limit. Messrs. Normanton received both contracts because they tendered at the lowest figure in each case. It has now been decided that they shall retain the contract for Sections A and B, and that Sections C and D shall be executed by Mr. E. Nuttall, whose tender was the next lowest.

Shrewsbury.—The Town Council at their meeting on Wednesday accepted the tender of Messrs. Edwin Danks and Company, Limited, Oldbury, for a new boiler for the electric station at £455.

FORTHCOMING EVENTS.

Tuesday, January 14th.—At 7.30 p.m. Institution of Electrical Engineers (Manchester Section). Meeting at Owens College; paper on "Feed Water for Boilers," by G. J. Wells. (Mr. Blount's paper has been deferred.)

At 8 p.m. Institution of Electrical Engineers (Glasgow Section). Meeting at the Institution of Engineers and Shipbuilders, 207, Bath Street, Glasgow. Paper on "Practical Notes on Continuous Current Distributing Mains," by John C. A. Ward.

At 8 p.m. Institution of Civil Engineers. Meeting. Paper to be submitted for discussion: "American Workshop Methods in Steel Construction," by H. B. Molesworth.

At 7.30 p.m. Institution of Electrical Engineers (Students' Section). Meeting to be held in the Physical Lecture Theatre of the Finsbury Technical College, Leonard Street. Paper to be read: "Single-Phase Induction Motors," by Mr. H. F. Northcote.

Wednesday, January 15th.—The meeting of the Institution of Electrical Engineers (Birmingham Section), has been postponed until the 22nd, so as not to clash with the conversazione of the Birmingham and Midland Institute.

At 5.30 p.m. Chemical Society meeting at Burlington House.

Friday, January 17th.—At 8 p.m. Institution of Civil Engineers. Students' meeting. Lecture: "The Theory of Heat-Engines," by Captain H. Riall Sankey, R.E. (Ret.), M.Inst.C.E.

NOTES ON WIRELESS TELEGRAPHY.

JUDGING from an interview reported in the *St. James's Gazette* with Marconi's manager, Mr. H. Cuthbert Hall, there appears to be no doubt in the minds of Mr. Marconi and his associates as to the feasibility of telegraphing across the Atlantic by wireless telegraphy. The past achievements of Marconi in this field entitle his opinions to the greatest respect, and it is difficult to explain the results alleged to have been obtained on any other theory than the actual transmission of the signals from the Cornish Station. The feat, however, so greatly exceeds what has previously been done that most people will prefer to suspend judgment until actual messages have been transmitted.

The station at Newfoundland is to be removed to Cape Cod or Cape Breton, or some other place where it is not likely to be interfered with by the monopolies of cable companies. The cost of a Marconi installation to work across the Atlantic is estimated by Mr. Cuthbert Hall at £20,000, whereas a single submarine cable is said to cost £700,000. A correspondent of a daily paper asks a rather pertinent question in connection with the commercial side of wireless cross-sea telegraphy, namely, why does not Marconi transmit commercial messages, say, to France, or other places where their system has already been proved to be practicable? The answer does not appear to be obvious.

There is a long article by Mr. William Maver in *Cassier's Magazine* on wireless telegraphy, its past and present status and prospects. It is mostly historical and descriptive of apparatus already familiar to our readers, but contains some novel and interesting statements. The amount of energy, says the author, employed in setting up the electric oscillations in a Marconi transmitter for a range of 186 miles is about 150 watts (10 volts and 15 amperes), or about one-fifth of a horse-power. An ordinary telegraph relay may be operated at a distance of 186 miles by an expenditure of three watts at the transmitting end of the wire, or with about one-fiftieth of the energy used in operating the transmitter in question. The actual energy used in operating the telegraph relay is about 0·24 watt, the rest of the energy being consumed in the wire itself. The waste of energy in wireless telegraphy is, of course, immensely greater owing to the fact that the density of the radiant energy decreases as the square of the distance.

The induction coil used in a wireless transmitter must be capable of producing a 10 or 12-in. spark, though, in actual work, the knobs are only separated by about ½ in. Mr. Maver does not believe much in the efficacy of tuning as a means of securing non-interfering messages. It was found not to be effective on the occasion of the recent international yacht races, off Sandy Hook, when three different sets of wireless telegraph apparatus were in readiness to report the progress of the races. Interference between the different sets was pronounced. The use of tuned apparatus has, however, one advantage; it greatly increases the range of transmission.

NOTES.

Late Correspondence.—

CRAWFORD-VOELKER LAMP.

With reference to the tests of the Crawford-Voelker lamp, to which attention has been drawn in your columns, and concerning which it has been pointed out that some important data referring to the lamps were not given, I have now pleasure in rectifying the omission. In the first place, I may be permitted to draw attention to the fact that the tests made by me were carried out in February and the following months of last year, as already recorded in the original article in your paper, and that the report was not made to or for the inventor or owner of the patents. As to the lamps, they were made, through an error, suitable for 194-volt circuit, not 200 as was intended, and they were therefore tested and run at 194 volts; they were selected by me of varying candle-power, and therefore could not be correctly described as 8 or 16 C.P. Of the 24 lamps which survived the 1,000 hours, the average initial candle-power, measured in the horizontal plane, was 14·45, the highest being 19·3, and the lowest 10·8; at the termination of the 1,000 hours the average candle-power was 11·8, the highest being 13·9, and the lowest 8·5; the lamps therefore at the end of test had still an average of 81·7 per cent. of their original illuminating power. Any other particulars as regards the lamps or tests I should be willing to communicate to you. In conclusion, though I certainly was under the impression at the time, and am now, that Sir W. Preece's tests and figures were of 8-C.P., 200-volt lamps, I find, on reference

to the original document which has been sent to me to-day at my request, that the candle-power of the lamps is not stated therein.

H. G. HOLDEN.

Gifford House, Blackheath,
January 8th, 1902.

[We are indebted to Colonel Holden for these additional particulars, which were unfortunately received too late for insertion in our "Correspondence" columns. We are, it is true, not much better off as regards material for a detailed criticism of the performance of the lamps; the candle-powers being so various, and the *average* efficiency only being stated in the report. However, further comment must be deferred.—EDS. ELEC. REV.]

ALUMINIUM.

As we go to press we have received the following notes from the writer of our recent article:—"I have only just noticed Mr. W. Murray Morrison's letter in your issue for January 3rd, which accuses me of interpolating incorrect figures of my own into my abstract of his paper. It seems to have escaped Mr. Morrison's attention that there are sometimes two totally different ways of saying the same thing. In his Table VI. he gives the 'price of copper wire in pence per lb.' as (say) 10d., and the 'equivalent price of aluminium for equal section in pence per lb.' as (say) 33·7d. Now, so far as my arithmetic reaches, 10 : 33·7 :: 1 : 3·37. Similarly, 'for equal conductivity' (*cf.*, Table VI.), 10 : 20·6 : : 1 : 2·06. I was made to say 2·03 by a clerical or printer's error. After all, 3·37 and 2·06 are only the rough reciprocal of 0·297 and 0·485 respectively. We both say and mean the same thing: if copper costs 1s. per lb., I can afford to pay 3·37s. for an equal section of aluminium; or 2·06s. for aluminium of equal conducting power—if the latter metal can be procured more cheaply, so much the better for my pocket.—YOUR ABSTRACTOR."

Sheffield Tramway Troubles.—The *Sheffield Daily Independent*, of Friday last, contains some notes respecting breakdowns which have occurred in the tramway generating plant, causing disorganisation of the system. We quote our contemporary as follows:—"For a great part the unfortunate incident of the submerged armature in the canal is held responsible. But for that accident it was expected that an additional large generator would have been running in October. Now it will be at least six weeks, or even two months, before it is erected. The state of affairs has become such that it is probable a few of the cars will have to be taken off whilst the generators are being overhauled. There are five of the latter at the electricity power station. The first is now being repaired, as it failed a fortnight ago; the second failed last Sunday, but has been patched up, and, whilst defective, is still running; the third is running satisfactorily; the fourth is defective, and needs to be shut down for three or four days. It was a breakdown on the part of this machine which caused the stoppage of a number of cars on Wednesday evening. The fifth generator is so defective that it is desirable that it should be shut down on Saturday. There are now about 120 cars running out of some 160 belonging to the Corporation, and if it is necessary to shut down some of the generators a reduction in the service will have to take place."

Personal.—Mr. R. A. Miles, who has been on the staff of the N.T. Company's factory in Nottingham, has accepted a position in charge of the manufacturing section for telephones and instruments recently started by the Electric and Ordnance Accessories Company, Limited, Stellite Works, Cheston Road, Birmingham (Messrs. Vickers, Sons & Maxim, Limited). He was presented on leaving Nottingham with a handsome black and copper pedestal lamp as a mark of esteem by his colleagues on the staff.

A New York exchange says that Mr. Lemuel Bannister, who for the last five years has been the general manager of the British Westinghouse Company, has resigned.

Energy From Refuse.—Mr. W. Sillery, electrical engineer to the Corporation of Wrexham, sends us particulars of the performance of the Meldrum refuse destructors at that town during December last. The units generated exclusively from refuse vary from 400 to 966 per day, the total for 23 working days (apart from Sundays and holidays, when no refuse was delivered) amounting to over 16,000 units. In addition to this, the destructor supplied steam to the furnace blowers, water softener, deep well pumps, condensing plant, &c. The boilers are of Messrs. Babcock & Wilcox's make. The electrical energy generated amounted to about 38 units per ton of refuse. These results prove, if proof were needed, that there is a good deal to be said for the refuse destructor as a source of energy, when it is of suitable design and properly looked after. Great assistance is to be obtained from storage in this connection, and at Wrexham, from a log sheet which we have received, it appears that the batteries were being charged on December 21st from 7.30 p.m. to 11.15 p.m., at the rate of over 60 KW., while the maximum load, which occurred at 7.30—9.0 p.m., including the battery charging, amounted to nearly 150 KW. Thus two-fifths of the maximum load was a charging load. As the battery was being charged for nearly four hours at about 60 KW., taking in all, say, 225 units, and the whole output for the day was 756 units, nearly one-third of the whole output went into the battery. This we believe to be a very good example to follow, and Mr. Sillery is to be congratulated on his results.

Priority of Invention of the Telephone.—The most interesting paper read at the last congress of the members of the Italian Electro-Technical Association, which was held at Rome, M. Guido Grassi presiding, was that contributed by Prof. Banti, editor of the *Elettricita*, of Rome, concerning the claim to priority of invention of the telephone put forward by the Italian Meucci. Prof. Banti has investigated the subject thoroughly, and he thinks that he has at last attained his object. Round the name of M. Meucci had gathered a great many legendary rumours, which have now been dissipated by the results of Prof. Banti's inquiry. It appears that M. Meucci died very poor, as he had lived. He was so poor that he was not able to take out a patent for the protection of his invention, which has since been worked by very clever speculators, who have derived immense profits from it. M. Banti was enabled, in the following manner, to procure the information which he laid before the Italian Electro-technical Association at their last meeting. M. Banti, like others, was acquainted with Meucci's work, but recently at a fine art exhibition in Florence he saw a bust, under which was inscribed, "The Inventor of the Telephone." The sculptor made M. Banti acquainted with one of M. Meucci's brothers, who is still living, and who was able to give him information of sufficient weight to obtain for M. Meucci an official and serious recognition of his claim. It is, moreover, an established fact that M. Meucci invented an apparatus which he called an "acoustic telegraph," and for which he took out a provisional specification. It was impossible for him to take out the complete patent on account of his want of means. M. Meucci entrusted his apparatus to someone who afterwards occupied an important position in the Bell Company. Moreover, the drawing and the description of M. Meucci's "acoustic telegraph" are as like those of the Bell telephone as one drop of water is to another. All the statements brought forward were so well authenticated that the members of the Italian Electro-technical Association decided unanimously to request the President, M. Guido Grassi, to appoint a committee to continue such official researches as would enable them, if possible, when a suitable occasion should present itself, to render posthumous honour to the memory of the Italian, Meucci. The committee could find many references to Meucci in the ELECTRICAL REVIEW for October 11th, 1884.

The Behr Railway.—Mr. Behr's lecture before the German Engineering Association did not evoke much favourable comment. The general opinion was all in favour of the ample sufficiency of the ordinary two rails. Mr. Behr seems to have made light of the centrifugal force fears. We, ourselves, share in those fears, because we have never yet learned how Mr. Behr can get at the back of what we accept as a fixed law, the first law of motion. The suspended railway was urged by Langen as the only one in which centrifugal force could have no effect on the passengers. No doubt he is not far wrong, if he will only provide for the lateral pull on the structure, which, of course, will be considerable. The so oft expressed fears as regards an ordinary two-rail track remind us of the early days of railroads, when rack rails were employed under the belief that smooth wheels had insufficient adhesion. One fine day it occurred to some man to try, and racks disappeared, until the days of the Righi and Pilatus justified their use. We look with interest for the appearance of the high-speed Behr railway, chiefly because we feel greatly interested in the motor design and location. The Λ-frame seems to us a great obstacle to a good motor design within reasonable width. Or is the motor to be perched up aloft? We quite appreciate the doubts of the German engineers. They are exactly what we have ourselves maintained all along.

German View of American Machine Shop Practice.—The continuation of Mr. Luder's article begins with the drawing office, the hours of which are condemned as too long. It is "impossible to do really good constructing work for eight or more hours a day, especially during an American summer." He compares some German offices to the disadvantage of the Americans, for in Germany in some works men work from 9 a.m. to 3 p.m. only without a break, and to the advantage for all concerned. This we can readily credit. Eight hours is too long for any draughtsman who is also a thinking engineer. The advantage of the American system is the multiplicity of blue prints allowed. In many works one drawing is made to serve too many men, and is apt to form a sort of centre of conversation. The worst of Mr. Luder's paper is its exaggeration in style and emphasis. Thus, dealing with the system of press buttons and call boys to carry messages to and from the men and foremen, he draws a mental picture of the men feverishly pressing the button and tearing away at their work to save every minute. We hear that American shops are nigger driven, but the impressions conveyed by Mr. Luder are, we feel sure, overdrawn. He is equally over-anxious to ascribe perfection in every detail to the finished product, as though all were faultless. Now, this is all a part of the advertising boom of the *Daily Mail* type, which is being so artfully worked by Americans or American Germans. Yet, all know that American products of the highest class are far from faultless, and we have frequently known of faults which have been at first denied as "impossible to have passed the inspection table." An American mechanic only recently stated to us that the idea was wrong that the average English shop was much behind the American in general, while the engine shops in England could very soon be put into the first rank, if not already in it. At the same time, American practice is not to be blindly followed. We certainly cannot say a word of approval for that new American craze that caused a strike at the new Westinghouse works at Manchester. Half-an-hour was to be allowed for the principal meal of the day for the workmen. Workmen are too prone to strike for bad reasons,

and we have been as severe on the follies of trades unions as anyone. It is a pity to give them a most excellent reason for striking. We wonder if the authors of this half-hour dinner hour take even so little for the lunch which forms the midday refresher of the evening diner. The working man is not an evening diner, and we do not believe he ought to be expected to be one. The danger of the American shop system—its effect on the men—is foreseen by the author. In America a boy drifts from being a call boy to working on a machine, and there, as a rule, he sticks. The American becomes a first-rate machine hand, and there he usually stays, rarely becoming any approach to the old-fashioned tradesman. This sort of thing will, says the author, bring death and not pulsating life—a poor end for automatic machines and model shops that is inevitable until men learn to use machinery to its utmost, and work men few hours only, such men on their part, we would add, living up to the new ideal, an attainment they don't seem to hanker for. They prate of tyranny and cannot deliver themselves from the "tyranny of the quart pot."

Correspondence Instruction.—The correspondence system of instruction has much to commend it, especially for the education of the mechanic, foreman, or practical man who has to run plant, but who possesses little or no real knowledge of the design and construction of the machinery. One of the aims of the correspondence system is to reach such men as these, and educate them in ways which will add at once to their value to their employers, and hence to their wage-earning power. The American School of Correspondence, Boston, Mass., issues sets of instruction papers and books, covering thoroughly the practical details of stationary, electrical, mechanical, marine and locomotive engineering, heating, ventilating and plumbing, and mechanical drawing. These courses are prepared by trained instructors of the best standing, and are well illustrated. Many of the instructors are regular teachers in the greatest resident schools of the United States. Young mechanics who lack means or facilities for technical education will be interested in the American school's introductory free scholarship.

The Lay Press Again.—A note recently appeared in a weekly contemporary to the effect that the King suddenly decided to have the electric light installed at Sandringham, and gave orders that it should be done within a fortnight, but was informed, after inquiry, that no British firm would do it in the time. "A lady suggested that if his Majesty would try Mr. Paris Singer, the American millionaire, he might obtain what he wanted. Mr. Paris Singer was communicated with, and he, though quite ignorant of electricity, undertook at once to have the installation completed in the time. Thus kings are satisfied and favourites made. But what shall be said of the ineffable British tradesman?" What indeed? Surely it is clear that the British tradesman knows his business better than even an American millionaire. But what is to be said of the unspeakable British journalist who writes such twaddle?

Lectures.—Two special courses of 10 lectures are to be delivered this month at the Royal Technical Institute, at Salford, as follows: Mr. John Morris on "Engineering Estimates and Specifications"; Mr. W. B. Burnie on "Electric Traction and Motive Power." An announcement appears in our advertisement pages to-day.

Tramways and Light Railways Association.—At a general meeting of the Tramways and Light Railways Association held at Hamilton House, Victoria Embankment, E.C., yesterday, Messrs. H. R. Beeton, T. O. Callender, C. H. Gadsby, Hugh C. Godfrey, F. J. Trewhitt, and A. M. Willcox were proposed as members.

Searchlight.—A New York telegram states that the Diamond Shoal lightship off Cape Hatteras will in future, in addition to the usual light, use a new electric searchlight. If it is a success, the new mariners' beacon will be installed at Fire Island, Sandy Hook, and all other principal stations.

Royal Institution.—The Friday evening discourse on January 17th will be delivered by Lord Rayleigh, his subject being "Interference of Sound." On January 31st Prof. A. Crum Brown will lecture on the "Ions of Electrolysis."

The fifth of Dr. Fleming's lectures on "Waves and Ripples" was delivered on Monday.

Appointments Vacant.—An electrical engineering assistant is wanted by the Gibraltar Sanitary Commissioners at £200 per annum, on conditions stated in our "Official Notices" to-day. A distributing engineer, at £180 per annum, is wanted by the Nottingham Corporation. Resident electrical and tramway engineer for Blackpool; working engineer for Islington new infirmary.

The Electrical Standardising, Testing, and Training Institution.—On Monday next, January 13th, Prof. C. A. Carus-Wilson, M.A., M.I.E.E., will commence a special course of lectures to the senior students of the above Institution upon "Dynamo, Motor, and Transformer Construction."

The Liverpool Railway Disaster.—At the adjourned inquest on Wednesday, the jury found that the death of the victims was due to accidental suffocation, but they were of opinion that a great oversight had been made by storing the sleepers in such a dangerous place.

The Influence of Aluminium upon the Carbon of Cast-Iron.—Messrs. Melland and Waldron have carried out a series of experiments on the amount of aluminium necessary to separate the largest quantity of graphite from white cast-iron, and on the influence of speed of cooling on the carbon in irons containing between 0·2 and 12 per cent of aluminium. The material employed was a white Swedish charcoal iron, and it was melted in batches of 1·4 to 1·8 kilos in a carbon-lined crucible. The aluminium was 99 per cent. pure. The alloys were made by melting the aluminium in the crucible, and then adding the iron; the samples were finally cast in moulds, some being chilled, others allowed to cool slowly. It was found that less than 2 per cent. of aluminium exerted no influence upon the total carbon content; larger additions reduced the percentage of carbon, *e.g.*, 2 to 11·8 per cent. of aluminium yielding alloys containing 0·12 to 0·39 per cent. of carbon. In the chilled samples less than 0·23 per cent. of aluminium did not affect the amount of graphite eliminated; but it increased as the proportion of aluminium rose to 0·53 per cent, then remained constant to 1·78 per cent., and then fell. In the slowly cooled specimens the action of small quantities of aluminium is irregular. Between 0·23 and 1·78 per cent. of aluminium the metals were grey and contained about 3 per cent. of graphite; larger additions of aluminium reduced the graphite, till at 11·8 per cent. of aluminium there was only 0·2 per cent. left. Unlike silicon, aluminium will not convert the whole of the carbon into graphite. The chilled metals were exceedingly fine in the grain. It was observed that aluminium carbide (Al_4C) was formed at a temperature below the melting point of cast-iron, which is probably the cause of the small separation of graphite when 8 to 10 per cent. of aluminium was added. The finely powdered material, however, evolved no hydrocarbon, nor could the carbide be seen on an examination of an etched and polished surface. Mechanical tests showed that the hardness of the iron was reduced 60 per cent. by the presence of 0·25 per cent. of aluminium; and the alloy possessed the properties of a good white cast-iron. In spite of the absence of its white skin, a sample containing 3·8 per cent. of aluminium had a strength of 121 kilos per sq. mm. in compression.

The Care of Street Railway Controllers.—In the *American Electrician* Mr. Frank Berry, jun., writes on this subject as follows:—"The controllers of a street railway car should be thoroughly inspected and cleaned at least once a week if the car is in regular service, as the cuttings and accumulations of dust are apt to cause a ground or short circuit if they are allowed to collect for any length of time. The controller should be carefully watched for burnt spots on the contact segments and fingers. Any rough place due to burning should be smoothed with a file until the fingers rest squarely upon the contact strips. Any finger that does not make a firm contact should be lowered, unless the trouble is due to a weak spring or excessive wearing, in which case the finger should be immediately replaced by a new one. If a controller has been inspected with a view to making sure that none of the contacts are broken earlier than they should be (which may be the case on account of excessive burning), the controller should be carefully cleaned with a cloth wherever the parts are accessible by this method, and a hand bellows should be used to blow the dust out of inaccessible places. In using the bellows, the connections at the base of the controller must not be overlooked, as an accumulation of dust there is liable to cause a breakdown in the controller leads. Any metal lodged on the flash-plates, which is due to arcing, should be scraped off. After the controller has been cleaned and inspected, a lubricant should be applied to the contact surfaces of the fingers, in order to prevent mechanical cutting. The lubricant most commonly used is vaseline, although soft motor grease is sometimes used for this purpose. Whatever form of lubricant is used, it should be used sparingly, in order that the contact surfaces may not become gummed. The ratchet should also be lubricated, but more freely than the contact surfaces, in order that the cylinder may have a free movement. When controllers are used with stops on the face-plate, special attention should be given, in order to make sure that the controller handles fit snugly on the shafts. The writer has seen controller handles in use which fitted so loosely, that upon moving the handle from the off position, there was a free play of half an inch on the part of the handle before the drum began to move, and on the 'loop' position some of the fingers which should have made contact scarcely touched, and were badly burned."

Instructions to Electricity Consumers.—We have received a wall-card of instructions which have been drawn up and issued to consumers by Mr. A. R. Sillar, borough electrical engineer to Colchester. The instructions are very simply worded, such as even the most unsophisticated consumer should readily understand, and are especially aimed at the avoidance of dirt and moisture. Users of currrent are warned not to interfere with the Corporation's main fuse, and to replace blown branch fuses with fuses of the correct capacity; the idea is a good one, and well worthy of imitation by other station engineers.

Obituary.—The death is announced of Sir J. T. Chance, head of the firm of Chance Brothers, glass manufacturers and lighthouse engineers, of Spon Lane, Birmingham. He was created baronet in 1900, for eminent services to science in lighthouse engineering and munificent philanthropy. In 1838 he was Seventh Wrangler in the Cambridge mathematical tripos, and on leaving college devoted himself to the business of glass manufacture, established by his father and uncle. Amongst the firm's achievements were lenses for searchlights on war vessels and the group-flashing light on lighthouses.

Non-electrical Calcium Carbide Again.—According to some of the papers, it would appear that the notion of making calcium carbide without the aid of electricity, and at a cost of nothing, or rather less, is once more being extensively "boomed," particular reference being again made to the product called "Carbolite," which is reputed to have been manufactured in America by Hartenstein from blast furnace slag. We desire to express no opinion on the point whether calcium carbide could or could not be sold remuneratively at a lower price than at present obtains in Great Britain; but as regards the broad question of non-electrical carbide, or carbide made electrically or otherwise from valueless waste products, it may be well to lay down a few general principles. Neglecting those early experiments dating from the first production of calcium carbide in the electric furnace, which experiments are, and always must be, of no practical significance whatever, there is at the moment absolutely no evidence that carbide has ever been manufactured without the assistance of the electric current. So far as can be seen from a study of its chemical properties and the reactions involved in its preparation, there is no probability that calcium carbide ever will be manufactured except in the electric furnace. We are aware that these statements may be disputed; we have even seen samples of carbide alleged to have been made non-electrically, and have heard a great deal about the processes employed. Nevertheless, we have no reason to alter our opinion. We are not aware that "carbolite" has ever yet been manufactured on a large scale. It has certainly never been made non-electrically. Hartenstein's idea was originally to treat a mixture of blast furnace slag and powdered coke in an electric furnace of some kind. Assuming "carbolite" ever was so made, except on paper—and there are no obvious theoretical grounds for denying that it could be—a syndicate or company bearing the name was founded, at any rate—it might easily contain a considerable proportion of various carbides, but the proportion of calcium carbide in it would be small. It would most probably yield much less than "5 ft. of gas per pound" on treatment with water. That gas would only contain a small proportion of acetylene; much of it would be methane, which burns with a practically non-luminous flame; it would be highly charged with numerous impurities, many of which would demand removal before the gas could be burnt for domestic purposes; and the whole material, unless it could be made and sold at a price which it is impossible to believe realisable, would never be able to find any extensive market, unless it proved exceptionally useful for the destruction of phylloxera, &c., among vines. Calcium carbide is already a distinctly serviceable material, and acetylene finds acceptance as an artificial illuminant in many of the wilder and less thickly populated parts of the world; but no good can be done to a small industry by making exaggerated claims on its behalf. Had it not been for action of this character in the past, the calcium carbide trade would have become more important than it at present is, and the "slump" and distress in the Continental carbide markets would probably have been avoided. Some time ago we read in a local paper the report of a lecture upon acetylene, in the course of which the speaker was made to say, "There never yet had been an accident with acetylene," . . . . which is quite incorrect. By a curious coincidence, or by a grim joke on the editor's part, the following paragraph in the same newspaper mentioned that a man had just injured himself somewhere in the same neighbourhood by an explosion of a gas generator of his own construction.

Keen Rivalry.—In one of our leading Colonial cities, not long ago, the electric lighting company found it necessary to "change-over" from 110 to 220 volts. Naturally this led to difficulties with the arc lamps, and although the operation of conversion was smartly carried out, many temporary expedients had to be made use of, to keep the lights going until a more favourable time for setting things in order. For example, two rival drapers, Jones and Brown, each boasted of two arc lamps running in series at 110 volts; the engineer simply ran a cable across the street (the conductors are all overhead) and coupled the four in series on 220 volts *pro tem.* Shortly after this performance, Mr. Jones came to his front door and observed that the shades of night were fast approaching; he therefore decided to switch on his two arcs, and so outshine his rival, for a brief period at least. Returning to his post, he was struck with the fact that Brown had also lit up. Evidently he had been watching for Jones to put on the current, and Jones was somewhat annoyed at this close surveillance—so much so, that he at once went indoors and switched off again. Once more he took up his stand at the gates of custom—and behold, *Brown had switched off too!*

"The bally idiot," says Jones; "what's his little game, anyway? I'll teach him!" So he promptly put on the switch again—and so, apparently, did Brown.

Here were the elements of a first-class row. But, fortunately, Jones was a philosopher. He would investigate. So he set a small boy to switch the lamps on and off, while he went to the door to see what Brown's next move would be. Already a crowd was gathering, curious to get at the cause of all this flickering, and various rumours were spreading. Mr. Brown's manager had sent off a messenger post haste to the electricity works to give the alarm—not being able to fathom the entirely mysterious behaviour of the two lamps over his stoep. But Jones, returning to the door, was astonished to find that Brown's lamps were flashing in synchronism with his own!

Happily the arrival of a workman from the station at this point put an end to the mystery. The circuit of four lamps was controlled by Jones's switch alone, but by an oversight he had not been informed of the fact.

Institution of Junior Engineers.—At the meeting of this Institution, held on January 3rd at the Westminster Palace Hotel, the chairman, Mr. Percival Marshall, presiding, a paper on "The Utilisation of Exhaust Steam" was read by Mr. John Buley.

NEW COMPANIES REGISTERED.

Electric Light, Power and Hiring Company, Limited (72,303).—This company was registered on December 30th, with a capital of £15,000 in £1 shares, to acquire and deal in electric plant, to let on hire or hire-purchase electric installations, to erect, fix, lay down, construct, convert, supply, sell, let on hire, repair and maintain cables, fittings, brackets, lamps, globes, posts, insulators and accessories thereto, and to carry on the business of electricians, engineers, suppliers of electricity for light, heat, power and other purposes, cycle, motor cycle and motor vehicle builders, &c. The first subscribers (each with one share) are:—J. T. Higham, Holly Grove, Accrington, cotton spinner; A. E. Higham, 9, Grantham Street, Blackburn, salesman; F. T. Sinclair, 30, Lonsdale Road, Levenshulme, clerk; A. Hawe, 3, Alma Terrace, Sale, Cheshire, clerk; A. Smethurst, Newfield, Haslingden, agent; Mrs. M. M. Smethurst, Newfield, Haslingden; and T. F. Bradbury, 57, Deardengate, Haslingden, draper. No initial public issue. The number of directors is not to be less than two nor more than five; the first are John S. Higham and Alfred Smethurst; qualification £500; remuneration as fixed by the company. Registered office, 491, Manchester Road, Haslingden.

British Prism Globe Electrical Company, Limited (72,339).—This company was registered on January 2nd, with a capital of £20,000 in £1 shares, to carry on the business of glass manufacturers and blowers, makers of prism globes and globe carriers, manufacturers of glass ware of any description, electrical and general engineers, suppliers of electricity, electricians, manufacturers of and dealers in electrical apparatus, &c., and to enter into an agreement with J. H. Pontefract (on behalf of the Prism Globe Company, incorporated in 1899). The subscribers are:—A. Davidson, 139, Norfolk Street, Sheffield, engineer, one share; E. W. Hatfield, 139, Norfolk Street, Sheffield, engineer, one share; J. H. Bardsley, 60, King Street, Manchester, chartered accountant, one share; W. Dearden, East Dene, Whitefield, near Manchester, chartered accountant, one share; E. Stanley, 57, Chancery Lane, W.C., engineer, one share; A. S. Brewis, 16, King's Grove, Heaton Moor, chartered accountant, one share; J. H. Boardman, 41, John Dalton Street, Manchester, solicitor, 500 shares. No initial public issue. The number of directors is not to be less than three nor more than seven. The subscribers are to appoint the first, subject to the right of the Prism Globe Company, Limited, to nominate two while holding 1,000 ordinary shares.

SUPPLY STATION ACCOUNTS.

Cheltenham Corporation Electricity Accounts.

THE accounts of the Cheltenham Corporation electricity department are not quite what we expected, and the results of the business for 1900 show a retrograde movement, which it is to be hoped may have been arrested last year. The growth of the output and load is satisfactory, but the latter is rising out of proportion to the former, compared with the previous year, and this being a falling off in the load factor, may explain to some extent the increased costs.

GENERAL STATEMENT.

	1899.	1900.	Inc.
Total capital expenditure ...	£90,839	**£12,827**	£21,988
Number of units sold	541,384	**653,364**	111,980
Maximum load in kilowatts ...	450	**560**	110
Number of lamps connected ...	—	**35,521**	—
Gross revenue	£8,580	**10,086**	£1,506
Gross expenditure...	£5,337	**£7,608**	£2,271
Gross profit	£3,243	**£2,478**	—£765
Average price per unit sold ...	3·64d.	**3·66d.**	+·02d.

The total capacity of plant installed has risen from 800 to 1,300 KW. Public lighting has been increased from 212 to 263 arc lamps, and in addition to this there are 18 32-C.P. and one 150-C.P. incandescents. The proportion of units sold was:—

Year.	Units generated.	Units to street lamps.	Units to private supply.
1898 ...	507,830	192,712	183,122
1899 ...	714,504	309,175	232,209
1900 ...	842,490	362,994	290,370

As the charges for the arc lamps vary from £19 10s. down to £14 10s. per annum, and the department is expected to supply the 32-C.P. incandescents for £5 2s. 6d. each per annum, while the sales to the public lighting very much exceed those to private consumers, it is not surprising that the business should be worked at a loss.

REVENUE STATEMENT.

	1899. Gross	1899. Per unit.	1900. Gross.	1900. Per unit.	Inc.
Sale of energy	£8,220	3·64d.	**£9,979**	3·66d.	+ ·02d.
Meter rents	3	·00d.	**6**	·00d	·00d.
Sale of old materials, &c. ..	357	·16d.	**101**	·04d.	— ·12d.
Sundry fees, &c...	—	—	—	—	—
Gross revenue ...	£8,580	3·80d.	**£10,086**	3·70d.	— ·10d.

The prices charged per unit to the private consumers are 6d. to 3½d. for lighting, and 3d. for power. The sale of energy shows a slight rise in the receipts per unit, but sales of material having

dropped by nearly ½d. per unit, the average return has fallen by $\frac{1}{10}$d.

Cost of Production.

	1899. Gross.	1899. Per unit.	1900. Gross.	1900. Per unit.	Inc.
Coal	£1,790	·79d.	£3,411	**1·25d.**	+·46d.
Oil, waste, water, and engine room stores.	380	·17d.	416	**·15d.**	−·02d.
Salaries and wages incurred in generation and distribution, and attending public lamps.	1,578	·70d.	1,960	**·72d.**	+·02d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c., and renewals, &c., of street lamps.	811	·36d.	939	**·35d.**	−·01d.
Works cost ...	£4,559	2·02d.	£6,726	**2·47d.**	+·45d
Rent, rates and taxes ..	140	·06d.	146	**·05d.**	−·01d.
Management expenses, salaries of managing engineer, secretary, clerks, &c.	413	·18d.	510	**·19d.**	+·01d.
General establishment charges, stationery and printing, law charges and insurance.	225	·10d.	226	**·08d.**	−·02d.
Other expenses	—	—	—	—	—
Total costs ...	£5,337	2·36d.	£7,608	**2·29d.**	+·43d.

The adverse effect due to the increase in the price of coal is carried both to works and total cost, as the other changes practically cancel out. The figure of 1½d. is higher than in 1898, but is not likely to be maintained. The total cost is back again to almost the same amount as in 1897.

Profit Statement.

	1899.	1900.
Interest on loans	£2,580	£3,888
Sinking fund for repayments	2,170	2,228
Net profit carried forward	−1,507	−3,638
Gross profit	£3,243	£2,478

The gross profit is less by £765 than in 1899, and as the financial charges require an additional £1,366, the net loss of £1,507 of the previous year is swollen by both these changes to the unfortunately large amount of £3,638. The interest and other capital payments are telling against the profit statement, and seem very heavy for the moderate capital expenditure involved.

Yarmouth Corporation Electricity Accounts.

A little over a year ago we were able to congratulate the Yarmouth Corporation upon the results of the previous financial year's trading. Unfortunately, the accounts we now analyse indicate a falling off, and the loss not only absorbs the profit of 1899, but leaves a sum approximately equal to that profit to be carried forward against future accounts.

General Statement.

	1899.	1900.	Inc.
Total capital expenditure ...	£40,265	**£44,392**	£4,127
Number of units sold	279,179	**356,882**	57,703
Maximum load in kilowatts ...	319	**383**	64
Number of lamps connected ...	—	**27,052**	—
Gross revenue	£6,457	**£7,225**	£768
Gross expenditure	£3,818	**£5,406**	£1,588
Gross profit	£2,639	**£1,819**	−£820
Average price per unit sold ...	5·01d.	**4·70d.**	−·31d.

The following figures showing the position of affairs during the last four years, are instructive:—

	Units generated.	Units. Public lamps.	Units. Private.	Total sold.	Maximum load kw.	Net profit.
1897	271,420	69,240	120,760	190,000	213	−£437
1898	333,731	78,500	165,169	243,669	267	−£57
1899	410,959	81,259	217,920	299,179	319	+£437
1900	507,144	83,527	273,355	356,882	383	−£632

There are now 77 10-ampere arc lamps for public lighting. The capacity of the plant installed is 735 kw. The prices charged are for lighting, 6d. and 4d., and for power, 3½d. per unit. Owing to the average price per unit sold having fallen by nearly ½d., the gross revenue has only increased by £768, notwithstanding an additional output of nearly 58,000 units.

Revenue Statement.

	1899. Gross.	1899. Per unit.	1900. Gross.	1900. Per unit.	Inc.
Sale of energy	£6,238	5·01d.	**£6,984**	4·70d.	−·31d.
Meter rents	202	·16d.	**232**	·16d.	·00d.
Sale of old material	4	·00d.	—	—	·00d.
Sundry fees, &c.	13	·01d.	**9**	·00d.	−·01d.
Gross revenue ...	£6,457	5·18d.	**£7,225**	4·86d.	−·32d.

Coal is the item that explains the difference in results. From 1·29d. per unit in 1898, it rose to 1·35d. in 1899, and again by ½d. to 1·85d. in 1900. Slight increase in wages, rates and taxes, and salaries, are not quite covered by reductions in repairs and establishment charges, the difference adding nearly $\frac{1}{10}$d. to the higher coal figure, and leaving total costs at almost 3⅔d. or nearly $\frac{3}{10}$d. above the previous amount.

Cost of Production.

	1899. Gross.	1899. Per unit.	1900. Gross.	1900. Per unit.	Inc.
Coal and unloading same ..	£1,687	1·35d.	£2,743	**1·85d.**	+·50d.
Oil, waste, water, and engine room stores and carbons.	379	·31d.	468	**·31d.**	·00d.
Salaries and wages incurred in generation and distribution, and attending street lamps.	646	·52d.	850	**·57d.**	+·05d.
Repairs and maintenance of buildings, engines, boilers, dynamos and public lamps.	214	·17d.	222	**·15d.**	−·02d.
Works costs ...	£2,926	2·35d.	£4,283	**2·88d.**	+·53d.
Rent, rates and taxes ..	200	·16d.	280	**·19d.**	+·03d.
Management expenses, salaries of managing engineer, secretary, clerks, &c.	563	·45d.	726	**·49d.**	+·04d.
Establishment charges, stationery and printing, law charges and insurance.	129	·10d.	117	**·08d.**	−·02d.
Other expenses	—	—	—	—	—
Total costs ...	£3,818	3·06d.	£5,406	**3·64d.**	+·58d.

The gross profit has fallen by £820, while the financial charges absorb £249 more than in 1899. Adding these two figures together we get a change of no less than £1,069, which turns the net profit of £437 into a loss of £632. The £371 brought forward from 1899 reduces this loss to £261, to which may be added a reserve for special rebates of £99, and a balance to cover bad debts of £20, making the actual loss carried forward, £380.

Profit Statement.

	1899.	1900.
Interest on loans	£1,141	£1,182
Sinking fund for repayments	1,061	1,269
Net profit carried to cover deficit in 1898	57	—
" " to cover bad debts in 1900 ..	9	—
" " forward..	371	−632
Gross profit	£2,639	£1,819

CITY NOTES.

Renewable Electric Lamp Company.

We learn that a meeting of this company was held at Winchester House on Wednesday. As we did not receive a copy of the directors' report, nor any notice of the meeting, we make the following extract from the *Times* report of the proceedings.

Mr. M. F. Armstrong presided, and formally moved the adoption of the report, which stated that, on taking over the duties of general manager on December 30th, 1900, Mr. H. E. Kershaw (one of the directors) found the organisation incomplete and unsatisfactory; and as the long-necked lamp had proved to be difficult to deal with on the market, he advised the board to abandon its manufacture. The board agreed to this proposal, and the manufacture of the ordinary type of incandescent lamp was then commenced. This change of policy meant the practical abandonment of the original patents. The company had purchased, during the year, the secret process of what the directors had reason to believe was a better filament than any at present in use by electric incandescent lamp manufacturers. From June last to the close of the financial year, on September 30th, about 100,000 lamps were manufactured, and in the three succeeding months ended 31st ult., 150,000 lamps were manufactured. The loss shown on the year's working was accounted for, to a large extent, by changes in management and organisation which had been found necessary.

Mr. Kershaw seconded the motion, and the report was adopted without discussion.

In compliance with a requisition received by the board, an extraordinary general meeting was afterwards held, Mr. Armstrong again presiding. Mr. A. Gilmer proposed, and Mr. Jacob Atherton seconded, a resolution to the effect that each of the directors should be removed from office. Owing to the resignation of Mr. J. E. Touch, the only remaining members of the board were the chairman and Mr. Kershaw. On a show of hands the resolution was not carried, but a poll was taken, with the result that it was passed. It was next moved and seconded that Mr. Gilmer, Mr. Atherton, and Mr. Gerald Partridge should be appointed directors. Mr. Kershaw said he had consistently opposed the policy of Mr. Atherton, one of the vendors, and that was the explanation of that gentleman's present action. He claimed that during the 12 months he had acted as manager he had turned a costly failure into a profit-earning concern. The resolution was passed, and Mr. Armstrong was also re-elected a member of the board.

Meeting.—A meeting of the debenture holders in the Blackpool Electric Tramways (South), Limited, was held on Monday at the Hotel Cecil, but the proceedings were not open to the press.

TRAFFIC RECEIPTS.

Blackburn Corporation Tramways.—The receipts for the week ending Jan. 3rd were £769; corresponding week last year, £678; increase, £91. Total to date, £341; corresponding period last year, £301; increase £40. Miles of track open, 10¾.

Bristol Tramways and Carriage Company.—The receipts for the week ending January 3rd were £4,304; corresponding period last year, £3,685; increase, £619.

Blackpool and Fleetwood Tramways.—The receipts for the week ending January 4th were £197 1s. 11d; corresponding week last year, £193 4s. 6d.; Total receipts for half-year ending 31st ult., £21,021 15s. 2d.; corresponding period last year, £20,435 18s. 10d.

British Electric Traction Company.—The following returns are issued of the undertakings of this company for the week ending December 27th :—

Company.	Amount £	Comparison with corresponding week of last year. + £	Comparison with corresponding week of last year. — £	No. of weeks.	Aggregate. Amount. £	Aggregate. Inc. or Dec. + £	Aggregate. Inc. or Dec. — £
Croydon*	647	357	—	52	18,032	2,804	—
Devonport	437	—	—	27	10,673	—	—
Dudley—Stourbridge	733	41	—	52	34,042	16,055	—
Gateshead	687	—	—	33½	19,797	—	—
Greenock-Pt. Glasgow	378	—	—	12	3,527	—	—
Hartlepool	225	3	—	52	11,580	1,240	—
Kidderminster ..	120	—	10	52	6,238	685	—
Merthyr	291	—	—	38	9,375	—	—
Oldham—Ashton ..	470	—	64	52	25,678	3,062	—
Poole	231	—	—	38	10,458	—	—
Potteries	1,569	129	—	52	72,805	19,928	—
Southport†	114	4	—	52	8,271	—	2,797
South Staffordshire‡	922	—	23	52	40,173	2,383	—
Swansea	615	19	—	52	22,906	4,315	—
Taunton	80	—	—	18½	1,442	—	—
Tynemouth	182	—	—	40	10,683	—	—
Wolverhampton Dist.	102	22	—	52	3,463	810	—

* Partly horse. † Reconstructing. ‡ Partly steam.

Central London Railway.—The receipts for the week ending Jan. 4th were £6,108; corresponding week last year, £5,847; increase, £261. Total receipts to date, £6,108; corresponding period last year, £5,847; increase, £261. Miles open, 6.

City and South London Railway.—The receipts for the week ending Jan. 5th were £3,176; corresponding week last year, £2,024; increase, £1,152. Miles open, 6¼; corresponding period last year, 4¾.

Dover Corporation Tramways.—The receipts for the week ending January 4th were £193 7s. 9½d.; corresponding week last year, £180 10s. 6d.; increase, £12 17s. 3½d. Total to date, £193 7s. 2½d.; corresponding period last year, £180 10s. 5d.; increase. £12 17s. 3½d. Miles of track open, 3. Car miles run, 1902, 5,093; 1901, 4,968. Number of cars, 1902, 12; 1901, 11.

Dublin United Tramways Company.—The receipts for four days ending Dec. 31st were as follows:—D.U.T. Co., electric cars, £1,995 10s. 5d.; D.S.D. Co., electric cars, £399 6s. 7d.; total, £2,394 17s. 0d.; corresponding period last year—D.U.T. Co., electric cars, £1,993 17s. 10d.; ditto, horse cars, £11 10s. 9d.; D.S.D. Co., electric cars, £425 3s. 1d.; total, £2,430 11s. 8d.; decrease, £35 14s. 8d.; aggregate to date, £122,581 5s. 5d.; aggregate to date last year, £121,919 14s. 2d.; increase, £661 11s. 3d. The mileage worked is 45 miles electrically, as against 43 miles electrically, and two miles by horses, for the corresponding period last year.—Receipts for three days ending January 3rd were as follows:—D.U.T. Co, electric cars, £1,615 19s. 4d.; D.S.D. Co., electric cars, £317 19s. 2d.; total, £1,933 18s. 6d.; corresponding period last year—D.U.T. Co., electric cars, £1,447 4s. 3d.; ditto, horse cars, £8 6s. 0d.; D.S.D. Co., electric cars, £310 10s. 2d.; total, £1,766 0s. 5d.; increase, £167 18s. 1d.

Glasgow Corporation Tramways.—Week ending January 4th £13,015 15s. 5d., compared with £11,534 13s. 2d. for the corresponding period last year.

Liverpool Overhead Railway.—The receipts for the week ending Jan. 5th were £1,402; corresponding week last year, £1,543; decrease, £141. Miles open, 6 miles 57 chains.

STOCKS AND SHARES.

Wednesday Evening.

THE remarkable outburst of speculative activity in the Kaffir market of the Stock Exchange has helped to stimulate business in all departments. So far from attention being diverted entirely to mining shares, the boomlet has quickened the general pulse, and even the devoted telegraph section is busy, although its trade is at the present moment of the kind with which few are in love. The crash in telegraph stocks and shares continues unabated, but the electricity supply market is good, without any material alteration in prices. Large lines of shares change hands every day, and to stand by the side of a jobber who deals in supply shares is an interesting object-lesson in estimating the increased popularity which now attaches to these investments.

The telegraph trouble begun by the Marconi scare is now accentuated by the foolish haste with which investors are tumbling over one another in their eagerness to sacrifice their holdings at any price. The falls in this department range from the 5 per cent. decline shown by Eastern Telegraph Ordinary stock downwards. Eastern Extension shares have lost 10s., equivalent to 5 points on £100 stock, and Globe Preference in shedding £1 display the largest proportionate fall in the list. Eastern Ordinary now stand at 130, and Eastern Extensions at 13, whereas the lowest prices touched last year were 135 and 12½ respectively. Anglo-American Preferred at 88½ compares with 86½, the bottom quotation of 1900, while the top was 102, and in 1900 the two ends of the see-saw were 117⅞ and 95. The dividend announcement from the Anglo-American Company is due very shortly, and the latest market estimate for the whole year's distribution on Anglo "A" is about nothing per cent. Yankee as well as British stocks are submitting to the same process of shrinkage, and it is some time since the market has presented the same opportunities for picking up cheap stock which exist at present.

National Telephone issues are a little better on the week; the Ordinary, Third Preference and 3½ per cent. Debentures are making small gains. The 4 per cent. Debenture stock is really 101 to 103, despite the Official List quotation of 99 to 103, and there is none to be had. In one case we know of a buyer who gave 101 for £1,000 stock last November, and he is still unable to obtain delivery of it. In fact, so scarce is the security that the jobbers decline to sell it unless the buyer promises he will not take steps to enforce its being delivered. United River Plate Telephones are ¼ down on the Argentine—Chili imbroglio, but Orientals keep steady at £1.

In the electricity supply market, Brompton Preference, by a 5s. rise, are now in line with the Ordinary shares. London Electric Preference are also better, but there the list of quotable changes ends. The principal shares being mostly "full of dividends," it is more easy to sell than to buy at the medium price of the quotations, and, as we noted above, the volume of business in the shares is large. Westminster fragments are 1s. 6d. premium, and the whole shares are ⅞ premium. Provincial varieties are about the same as they were at the end of last year. Oxfords are 5½, Bournemouth and Poole 12½, the Preference 10, and Folkestones 5½. Hove Electrics are 7 to 8. To go farther afield, Calcutta Electrics are 8 and 7½ for the Ordinary and Preference respectively, Electric Lighting of Australia Preference 4½, and River Plate Electric 5 per cent. Debenture 60 to 70. Royal Electric of Montreal 4½ per cent. Debenture are 105.

Some weeks ago a correspondent took us to task because we do not quote in every issue a full list of out-of-the-way shares connected with electric lighting. That our list of quotations embraces a good many which it is not usual to find generally noted is, however recognised in other directions, and in the City Notes of this week's *Sketch* a writer on the subject refers to this journal as affording a useful list to those who have any trouble in getting electrical prices. We are not fond of trumpet-blowing, and in all modesty quote our lively contemporary.

Electrical railway descriptions are very quiet, pending dividend declarations. There seems to be a distinct approach towards more harmonious working between the District and the Metropolitan Companies which will be gratefully welcomed by the stockholders in both concerns. New railway schemes are being discussed every day, and occasionally "private" circulars go out inviting subscribers to companies which are to be formed to do all sorts of wondrous things by tube-tapping the traffic of the metropolis. Of such schemes let the wary investor be very suspicious. It is unlikely that any important public emission connected with electrical railway enterprise will be made until some progress has been made with the numerous private Bills awaiting the attention of the next Parliament.

British Electric Traction shares are steady, and the Debenture stock is up a brace of points. London United Tramway Preferences remain at £1 premium, and the Debentures at £2 premium. In connection with the latter, we hail with delight the defeat of the Inland Revenue extortioners who have been trying to levy stamp duty on the full nominal value of stock when transferred, whether it be all called up or not. It is now admitted that this newly-found law is not in order, which gives all the more reason for hoping that the same stupid enactment with regard to shares will also be weighed in the balance and found to be as much wanting in legality as it is in sense or fairness.

In the miscellaneous market a dull tone prevails. Telegraph Constructions are lower, so also are British Insulated Wire, although the Preference shares of the last are ¼ better on the week. Brush Preference have improved, and find buyers over 2. India-rubber shares are flat on the telegraph slump, which is also, of course, responsible for the drop in Constructions. Crompton Debentures have weakened a point, and one or two other similar securities are quoted *ex* the dividends, which have not yet been recovered.

Part of the recent rise in the famous De Beers diamond shares is ascribed to the new electrical equipment which has just been ordered for the company, in America, we regret to say. The price is said to be £50,000. Of course, electrical equipment for mining companies is no new thing, and some of the Kolar undertakings in India have proved its utility long ago.

SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1898.	1899.	1900.	Closing Quotation Jan. 1st.	Closing Quotations Jan. 8th.	Business done during week ended Jan. 8th. 1902. Highest.	Lowest
82,300	African Direct Telegraph, 4 % Debs.	100	...	...	...	99 —102	97 —101 xd	100½	...
25,000	Amazon Telegraph Co.'s shares, Nos. 1 to 25,000	10	...	...	...	3½— 4½	3½— 4½	...	...
119,700£	Amazon Telegraph 5 % Debs., Nos. 1 to 1,250 Red. ...	100	...	...	...	78 — 83	78 — 83	...	..
804,720	Anglo-American Telegraph	Stock	£3 9s.	73/6	3½%	49 — 52	47 — 50	48⅝	47
3,097,640	Do. do. 6 % Pref.	Stock	6 %	6 %	6 %	91 — 94	87 — 90	92	88
3,097,640	Do. do. Deferred	Stock	18s. %	£1 7s.	5s. %	8 — 8½	7½ — 8	8¼	7⅝
44,000	Chili Telephone, Nos. 1 to 44,000	5	3 %	4 %	5 %	3½— 4	3½— 4	...	...
$3,333,300$	Commercial Cable	$100	8 %	8 %	...	170 —175	165 —170	xd &	bonus
1,741,029£	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	...	...	...	96 — 98 xd	94 — 97 xd	96	94
16,000	Cuba Telegraph	10	8 %	7 %	...	5 — 6	5 — 6	...	...
6,000	Do. 10 % Pref.	10	10 %	...	...	13½— 14½	13½— 14½	...	...
12,931	Direct Spanish Telegraph	5	4 %	4 %	4 %	3 — 4	3 — 4	...	...
6,000	Do. do. 10 % Cum. Pref.	5	...	...	...	8½— 9½	8½— 9½	...	...
30,000£	Do. do. 4½ % Debs.	50	...	...	...	100 —104 %	98 —102 xd	...	..
60,710£	Direct United States Cable	20	3½%	3½%	3½%	9½— 10½	9 — 10	9 1/16	9⅛
101,300	Direct West India Cable, 4½ % Reg. Deb. ...	100	...	...	...	99 —102	99 —102 xd	101	..
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	7 %	130 —140	125 —135	134½	125
1,930,807	Do. 3½ % Pref. Stock	100	...	...	...	91 — 94	88 — 92	91	88½
1,432,268£	Do. 4 % Mort. Deb. Stock Red.	Stock	...	...	...	111 —116	106 —111	108	106
300,000	Eastern Extension, Australasia, and China Telegraph ...	10	7 %	7 %	7 %	13 — 14	12½— 13½	13⅛	12½
320,000£	Do. 4 % Deb. Stock	Stock	...	...	...	113 —118	111 —116	...	..
300,000£	Eastern and South African Telegraph, 4 % Mort. Deb. Nos. 1 to 3,000, red. 1909	100	...	5¼%	...	100 —103	100 —103	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1—8,000	25	...	...	...	100 —103 %	100 —103	100	...
180,227	Globe Telegraph and Trust	10	5½%	5½%	5½%	9 — 10	9 — 10	9 1/16	9
180,042	Do. do. 6 % Pref.	10	6 %	...	...	14 — 15	13 — 14	14¼	13
150,000	Great Northern Telegraph, of Copenhagen	10	12½%	...	15 %	30 — 32	27 — 29	30	28
75,000	Halifax and Bermuda Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	99 —103 xd	99 —103 xd	...	...
17,000	Indo-European Telegraph	25	10 %	10 %	10 %	40 — 44	40 — 44	...	...
100,000£	London Platino-Brazilian Telegraph, 6 % Debs.	100	...	...	...	103 —106	103 —106	...	...
72,680	Montevideo Telephone, Limited, Ord., Nos. 1 to 72,680 ...	1	...	2½%	...	¼— ½	¼— ½	...	...
86,492	Do. do. do. 5 % Pref., Nos. 1 to 86,492	1	4 %	5 %	...	¾— 1	¾— 1	...	..
590,000	National Telephone, 1 to 590,000	5	6 %	5 %	5 %	3½— 3⅝	3½— 3¾	3 9/16	3⅝
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	12 — 14	12 — 14	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	12 — 14	12 — 14	..	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	5 %	4⅝— 4⅞	4¾— 5	4⅞	4 13/16
2,000,000£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	93 — 96 xd	94 — 97 xd	...	...
500,000£	Do. 4 % Deb. Stock Red.	100	...	...	4 %	99 —103 xd	99 —103 xd	103	100½
171,504	Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid	1	5 %	5 %	6 %	1 1/16—1 1/16	1 1/16— 1 1/16	...	...
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000 ...	100	...	...	...	99 —102 xd	99 —102 xd	...	...
11,839	Reuter's	8	5 %	5 %	5 %	7 — 8	7 — 8	...	...
3,303	Submarine Cables Trust	Cert.	...	...	...	120 —125	120 —125	...	...
58,000	United River Plate Telephone	5	6 %	7 %	...	5 — 5½xd	4¾— 5½xd	...	...
40,006	Do. do. 5 % Cum. pref. Nos. 1—40,000	5	...	...	...	4½— 5 xd	4½— 5 xd	...	...
179,947£	Do. do. 5 % Debs.	Stock	...	...	...	102 —105 xd	102 —105 xd	...	...
155,600	West African Telegraph, 5 % Debs....	100	...	...	...	100 —103	100 —103	...	...
30,008	West Coast of America, Nos. 1—30,000 and 53,001—53,008	2½	...	...	...	⅛— ⅜	⅛— ⅜	...	...
150,000£	Do. do. 4 % Debs., 1—1,500 gua. by Bras. Sub. Tel.	100	...	...	...	101 —104	99 —102 xd	...	...
207,930	Western Telegraph, Ltd., Nos. 1—207,930	10	7 %	7 %	7 %	12 — 13	12 — 13	12½	12
75,000£	Do. do. 5 % Debs. 2nd series, 1906 ...	100	...	...	...	102 —105 xd	102 —105 xd	...	...
348,777£	Do. do. 4 % Deb. Stock Red.	100	...	...	...	101 —104 xd	101 —104 xd	...	...
88,321	West India and Panama Telegraph	10	2 %	⅝%	...	⅜— ⅝	⅜— ⅝	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref. ...	10	...	...	...	5 — 6 xd	5 — 6	5½	...
4,669	Do. do. do. 6 % Cum. 2nd Pref. ...	10	...	...	...	2½— 3½	2½ - 3½	2⅞	...
80,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	...	...	...	100 —103 xd	102 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

100,000	Blackheath and Greenwich Dist. Electric Light, Ord. ...	1	...	...	...	⅜— ⅝	⅜— ⅝	...	...
100,000	Do. 4½% 1st Deb. Stock, Prov. Certs.	100	...	...	...	97 —102	97 — 102	...	...
19,661	Brompton & Kensington Elec. Lt. Sup., Ord., 101 to 19,761	5	6 %	6 %	6 %	8¾— 9¼	8¾— 9¼	...	...
20,000	Do. do. 7 % Cum. Pref....	5	...	...	...	8¾— 9	8¾— 9¼	...	...
50,000	Charing Cross and Strand Electricity Supply	5	8 %	9 %	9 %	8 — 9	8 — 9	8¼	...
50,000	Do. do. do. do. 4½% Cum. Pref.	5	...	...	...	5 — 5½	5 — 5½	5⅜	...
250,000	Do. do. do. 4% Deb. Stock Red.	100	...	...	...	103 —105	103 —105	...	...
34,000	*Chelsea Electricity Supply, Ord.	5	6 %	6 %	5½%	5½— 6	5 — 5½	...	...
150,000£	Do. do. do. % Deb. Stock Red. ...	Stock	...	...	...	108 —111 xd	108 —111 xd	...	...
70,579	City of London Electric Lighting, Ord. 40,001—110,579...	10	6 %	4 %	0 %	9 — 10	9 — 10	9	...
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	12 — 13	12 — 13	12 9/16	...
400,000£	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	...	...	...	121 —126 xd	121 —126 xd	...	...
200,000	Do. 4½% 2nd Deb. Stock, Prov. Certs., all paid	100	...	...	...	101 —104 xd	101 —104 xd	101¾	...
40,000	County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—40,000	10	nil	4 %	4 %	8½— 9½	8½— 9½	...	...
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	6 %	12 — 13	12 — 13	12⅜	...
400,000£	Do. 4½ % Deb. Stock, Prov. Certs (all paid) Rd. ...	...	...	...	...	104 —107 xd	105 —108 xd	...	...
35,500	Edmundson's Elec. Corp., Ord. Shares	5	6 %	6 %	7 %	5½— 6	5½— 6	5 13/16	...
20,000	Do. do. 6 % Cum. Pref.	...	...	...	...	5½— 6	5½— 6	...	...
120,000£	Do. do. 4½ % 1st Mort. Deb. Stock. ...	100	...	...	...	105 —108	106 —109	...	...
21,000	Kensington and Knightsbridge Electric, Ord.	5	...	...	...	11 — 12	11 — 12	...	...
90,000	Do. do. do. 4 % Deb. Stock	Stock	...	...	...	103 —106	103 —106	...	...
110,000	London Electric Supply Corporation, Limited, Ord. ...	3	...	...	...	1½— 1⅝	1½— 1⅝	...	...
49,840	Do. do. do. do. 6 % Pref.	5	6 %	...	...	3½— 4½	4 — 5	...	...
250,000£	Do. do. do. do. 4% 1st Mt. Db. Stock Rd.	Stock	...	...	...	94 — 98	94 — 98	...	...
98,769	Metropolitan Electric Supply, 101 to 62,500	10	5 %	5 %	6 %	14 — 15	14 — 15	14 13/16	14½
220,000£	Do. 4½% First Mortgage Debenture Stock	...	...	...	...	111 —115 xd	111 —115 xd	...	...
250,000£	Do. 3½% Mort. Deb. Stock Red.	Stock	...	...	...	96 — 99 xd	96 — 99 xd	...	...
8,652	Notting Hill Electric Lighting	10	6 %	7 %	7 %	15 — 16	15 — 16	...	...
40,000	St. James's and Pall Mall Electric Light, Ord.	5	14½%	14½%	14½%	15½— 16½	15½— 16½	16⅛	15¾
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	8½— 9½	8½— 9½	...	...
150,000£	Do. do. 3½ % Deb. Stock Red. ...	100	...	...	...	97 —100 xd	97 —100 xd	...	...
12,000	Smithfield Market Elect. Supply, Ord.	5	...	...	...	2 — 2½	2 — 2½	...	...
50,000£	Do. do. 4 % Deb.	100	...	...	...	80 — 90	80 — 90	...	...
65,000	South London Electricity Supply, Ord.	5	...	...	...	2 — 2½	2 — 2½	...	...
109,518	Westminster Electric Supply, Ord.	5	12 %	13 %	10½%	11½— 12⅛	11½— 12½	...	...

* Subject to Founders Shares. † Quotations on Liverpool Stock Exchange.
‡ Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital.
§Dividends marked ‖ are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES.—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share.	Dividends for the last three years. 1898.	1899.	1900.	Closing Quotation Jan. 1st.	Closing Quotation Jan. 8th.	Business done week ended Jan. 8th, 1902. Highest	Lowest.
20,000	British Aluminium 7 % Cum. Pref.	‡ 10	...	...	...	4½ — 5½	4½ — 5½	...	...
300,000*l*	Do. do. 5 % 1st Mort. Deb. Stock Red. ...	Stock	...	...	...	87 — 91	87 — 91	...	...
62,074	British Electric Traction	10	6 %	8 %	9 %	13½ — 14½	13½ — 14½	14 1/16	13 7/8
90,000	Do. do. 6 % Cum. Pref.	10	...	...	...	12 — 12⅔	12 — 12⅔	12⅝	12½
600,000*l*	Do. do. 5 % Perpetual Debenture Stock ...	Stock	...	...	...	124 —127	126 —129	127¾	127
70,000	British Insulated Wire Ord.	5	15 %	20 %	15 %	8 — 9	7½ — 8½	...	...
70,000	Do. do. 6 % Cum. Pref.	5	...	...	...	5½ — 6	5¾ — 6¼	...	...
50,000	¶Browett, Lindley & Co. (1899), Ord.	£1	...	...	8 %	⅛ — 1	⅛ — 1	...	...
50,000	¶ „ „ „ 6 % Cum. Pref.	£1	...	...	6 %	1⅛ — 1 1/16 xd	1⅛ — 1⅛	...	...
105,731	Brush Elecl. Enging., Ord., 1 to 105,731	2	4 %	5½ %	5 %	1⅝ — 1⅞	1⅝ — 1⅞	1½	...
150,000	Do. do. Non-cum. 6 % Pref.	2	6 %	6 %	6 %	1⅞ — 2⅛	2 — 2¼	...	...
125,000*l*	Do. do. 4½ % Perp. Deb. Stock	Stock	...	...	...	102 —105	102 —105	...	...
125,000*l*	Do. do. 4½ % Perp. 2nd Deb. Stock ...	Stock	...	...	...	99 —102	99 —102	...	...
30,000	Callender's Cable Construction shares, Nos. 1—30,000 ...	5	15 %	15 %	15 %	16½ — 17½	16½ — 17½	17⅜	17¼
40,000	Do. do. 5 % Cum. Pref.	5	...	...	...	5⅜ — 6¼xd	5⅜ — 6¼xd	5⅞	...
90,000*l*	Do. do. 4½ % 1st Mort. Deb. Stock Red ...	Stock	...	...	...	110 —114 xd	110 —114 xd	...	...
1,969,800	Central London Railway, Ord. Stock	Stock	...	...	...	105 —108	105 —108	107⅜	106½
440,100	Do. do. 4 % Pref. Stock	Stock	...	...	...	105 —108	105 —108	...	...
440,100	Do. do. Def. do.	Stock	...	...	...	106 —109	106 —109	107½	...
855,000	City and South London Railway	Stock	2⅛%	1⅞%	1½%	62 — 64	62 — 64	64	63½
47,500	Do. do. Ord. shares Nos. 22,501 to 70,000	10	...	...	...	6 — 6½	6 — 6½	...	...
54,000	Crompton & Co., Nos. 1 to 54,000	3	6 %	7½%	8 %	3 — 3½	3 — 3½	3⅜	...
100,000*l*	Do. 5 % 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 red	...	...	...	...	100 —105	99 —104 xd	100½	...
99,261	Edison & Swan Utd. El. Lgt., "A" shares, £3 pd. 1 to 99,261	5	6 %	6 %	2½%	⅛ — ⅜	⅛ — ⅜	...	...
17,139	Do. do. do. "A" Shares, 01—017,139 ...	5	6 %	6 %	2½%	2 — 3	2 — 3	...	...
344,023*l*	Do. do. do. 4 % Deb. Stock Red ...	100	...	...	...	78 — 83 xd	78 — 83 xd	...	...
100,000*l*	Do. do. 5% 2nd Deb. Stock Prov. Certs. all pd.	100	...	...	...	84 — 89	84 — 89	...	...
112,100	Electric Construction, 1 to 112,100	2	6 %	6 %	6 %	1¾ — 2¼	1¾ — 2¼	...	...
31,390	Do. do. 7 % Cum. Pref., 1 to 31,390... ...	2	7 %	...	...	2½ — 3	2¼ — 3	2⅞	...
182,500*l*	Do. do. 4 % Perp. 1st Mort. Deb. Stock ...	Stock	...	...	...	98 —102	98 —102	...	...
18,000	General Elec. Co. (1900) 5 % Cum. Pref.	10	...	...	...	9¾ — 10¼ xd	9¾ — 10¼xd	10	...
150,000	Do. do. 4 % Mort. Deb.	Stock	...	...	...	99 —102	99 — 102	...	...
35,000	Henley's (W. T.) Telegraph Works, Ord.	5	14 %	15 %	20 %	16¼ — 17½	16¼ — 17½	17⅜	17¼
35,000	Do. do. do. 4½ % Pref.	5	...	4½%	4½%	5½ — 6	5½ — 6	...	...
50,000*l*	Do. do. do. 4½ Mort. Deb. Stock...	Stock	...	...	...	112 —116	112 —116	...	...
50,000	India-Rubber, Gutta-Percha and Telegraph Works ...	10	10 %	10 %	...	21½ — 22½xd	20½ — 21½xd	21½	20¾
300,000*l*	Do. do. do. 4 % 1st Mort. Deb	100	...	...	...	100 —103	100 —103	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	3½%	3⅝%	3½%	5⅞ — 6⅛	4⅜ — 5	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5	...	12 — 12½	11¼ — 11⅜	...	...
7,500	Parker (Thomas), Limited, Ord., Nos. 1 to 7,500	10	...	...	...	15½ — 16½	15½ — 16½	...	...
	§Rosling, Appleby & Fynn 6 % Cum. Pref.	£1	...	...	6 %	... — ...	19/- to 20/-	...	...
37,350	Telegraph Construction and Maintenance	12	15 %	15 %	17½%	37 — 41	36 — 40	36	...
150,000*l*	Do. 4 % Deb. Bds. Nos. 1 to 1,500 Red. 1909 ...	100	...	...	...	104 —106	102 —104 xd	...	...
25,000	Telegraph Manufacturing, Ord. Nos. 1 to 25,000	5	8 %	12 %	12 %	10½ — 11½	10½ — 11½	...	...
20,000	Do. do. 5 % Cm. Prf. Nos. 1 to 20,000 ...	5	...	...	...	5½ — 6	5½ — 6	...	...
540,000*l*	Waterloo and City Railway, Ord. Stock	100	3 %	3 %	3 %	91 — 94	91 — 94	93¾	93½

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. § From Bradford Share List.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Consolidated Telephone Construction and Maintenance 2/—4/-
National Electric Free Wiring, 17/6 paid, ½—¾.

Oldham, Ashton, and Hyde Electric (£10 pd.), Ord., 15½—16.
Do. do. Pref. (£10 pd.), 10¼—10⅝.

* From Birmingham Share List. ¶ From Manchester Share List.

Bank rate of discount 4 per cent. (October 31st, 1901).

MARKET QUOTATIONS, Wednesday, January 8th.

CHEMICALS, &c.		This week.	Last week.	Inc. or Dec.
a Acid, Hydrochloric	per cwt.	5/-	5/-	..
a „ Nitric	per cwt.	23/-	23/-	..
a „ Oxalic	per cwt.	32/-	32/-	..
a „ Sulphuric	per cwt.	5/6	5/6	..
a Ammoniac, Sal	per cwt.	39/-	39/-	..
a Ammonia, Muriate (crystal) ..	per ton	£33 10	£33 10	..
a „ „ ..	per ton	£30	£30	..
a Bleaching powder	per ton	£7	£7	..
a Bisulphide of Carbon	per ton	£15	£15	..
a Borax	per ton	£13	£13	..
a Benzole (90 %)	per gal.	7/-	7/-	..
a „ (50/90%)..	per gal.	5/6	5/6	..
a Copper Sulphate	per ton	£19	£19	..
a Lead, Nitrate	per ton	£24	£24	..
a „ White Sugar	per ton	£31	£31	..
a „ Peroxide	per ton	£27 10	£27 10	..
a Methylated Spirit	per gal.	2/6	2/6	..
a Naphtha, Solvent (90% at 160° C).	per gal.	5/6	5/6	..
a Potash, Bichromate, in casks..	per lb.	8d.	8d.	..
a „ Caustic (75/80%) ..	per ton	£24	£24	..
a „ Bisulphate	per ton	£85	£85	..
a Shellac	per cwt.	125/-	125/-	..
a Sulphate of Magnesia	per ton	£4 10	£4 10	..
a Sulphur, Sublimed Flowers ..	per ton	£6 5	£6 5	..
a „ Recovered	per ton	£5 10	£5 10	..
a „ Lump	per ton	£5	£5	..
a Soda, Caustic (white 70 %) ..	per ton	£10 15	£10 15	..
a „ Crystals	per ton	£8	£8	..
a „ Bichromate, casks ..	per lb.	2¼d.	2¼d.	..

METALS, &c.				
b Aluminium Ingots, in ton lots	per ton	£148	£148	..
b „ Wire, in ton lots	per ton	£224	£224	..
b „ Sheet, in ton lots	per ton	£191	£191	..
p Babbitt's metal ingots.. ..	per ton	£75 to £125	£75 to £125	
c Brass (rolled metal 2" to 12") basis	per lb.	7½d.	7½d.	..
c Tube (brazed)	per lb.	8⅜d.	8⅜d.	..
c „ „ (solid drawn) ..	per lb.	7⅞d.	7⅞d.	..
c „ Wire, basis	per lb.	7½d.	7½d.	..
c Copper Tubes (brazed) ..	per lb.	9½d.	9½d.	..
c „ „ (solid drawn) ..	per lb.	9⅝d.	9⅝d.	..
g Copper Bars (best selected) ..	per ton	£66	£66	..

METALS, &c. *(continued.)*		This week.	Last week.	Inc. or Dec
g Copper Sheet	per ton	£66	£66	..
g „ Rod	per ton	£66	£66	..
c „ Electrolytic) Bars ..	per ton	£70	£70	..
c „ „ Sheets	per ton	..	..	..
c „ „ Rod	per ton	£75	£75	..
c „ „ H.C. Wire ..	per lb.	⅞d.	8¼d.	..
f Ebonite Rod	per lb.	8/-	8/-	..
f „ Sheet	per lb.	8/-	8/-	..
n German Silver Wire	per lb.	1/5	1/6	..
h Gutta-percha fine	per lb.	8/-	8/-	..
h India-rubber, Para fine	per lb.	8/4½ to 3/7	3/6 to 8/7	dec.
i Iron, Charcoal Sheets	per ton	£18	£18	..
i „ Pig (Cleveland warrants) ..	per ton	43/7	43/3½	3½d. inc.
i „ Forgings, according to size	per ton	From £11	From £11	..
i „ Scrap, heavy	per ton	47/6 to 50/-	47/6 to 50/-	..
i „ Wire, galvanised No. 8 ..	per ton	£10	£10	..
g Lead, English Ingot	per ton	£10 15 to £11	£10 7 6 to £10 15	inc.
g „ „ Sheet	per ton	£13 10	..	..
m Manganin Wire No. 28	per lb.	8/-	8/-	..
g Mercury	per bot.	£8 15	£8 17 6	2s. 6d. dec.
d Mica (in original cases), small ..	per lb.	3d. to 9d.	3d. to 9d.	..
d „ „ „ medium	per lb.	1/9 to 2/9	1/9 to 2/9	..
d „ „ „ large ..	per lb.	3/8 to 7/8	3/8 to 7/8	..
p Phosphor Bronze, plain castings	per lb.	1½d. to 1 2	1½d. to 1 2	..
p „ rolled bars & rods	per lb.	1/- to 1 3	1/- to 1 3	..
p „ „ strip & sheet	per lb.	From 1 2	From 1 2	..
o Platinum	per oz.	£4 1	£4 1	..
p Silicium Bronze Wire	per lb.	10d. to 1/-	10d. to 1/-	..
i Steel, Magnet, acc'd'ng to desc'p'n	per ton	From £15 to £40	£58	..
i „ „ in bars		£58	£58	..
g Tin, block	per ton	£106 to £107	£118 to £109	£2 dec.
g „ foil	per lb.	1/6	1/6	..
n „ wire, Nos. 1 to 16	per lb.	1/4½	1/7	2½d. dec.
p White Anti-friction Metals — "White Ant" brand	per ton	£85 to £65	£85 to £85	..
j Yarns, 2/10s Grey Cotton, on sp'ls	per lb.	7d.	7d.	..
j „ 6 lea. Flax	per lb.	5⅝d.	5⅝d.	..
j „ 3 ply 10 lbs. Russian ..	per lb.	4⅛d.	4⅛d.	..
j „ 10 lbs. Russian, single ..	per lb.	4½d.	4½d.	..
j „ 150 lbs. Jute rove	per ton	£10 2 6	£10 2 6	..
k Zinc, Sh's. (Vielle Montagne bnd.)	per ton	£21 10	£21 10	..

Quotations supplied by { a Messrs. G. Boor & Co. b The British Aluminium Co., Ltd c Messrs. Thos. Bolton & Sons. d Messrs. F. Wiggins & Sons. e Messrs. Frederick Smith & Co.

Quotations supplied by { f India-Rubber, G.-P. and Teleg. Works g Messrs. James & Shakspeare. [Co., Ltd. h Messrs. Edward Till & Co. i Messrs. Bolling & Lowe. j Messrs. Walter H. Hindley & Co.

Quotations supplied by { k Messrs. Morris Ashby, Limited. m Messrs. W. T. Glover & Co., Ltd. n Messrs. P. Ormiston & Sons. o Messrs. Johnson, Matthey & Co., Ltd p The Phosphor Bronze Company, Ltd.

* Subject to Founders Shares. † Quotations on Liverpool Stock Exchange.
‡ Unless otherwise stated all shares are fully paid. § Dividends paid in deferred share warrants, profits being used as capital.
¶Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

APPLICATIONS AND USES OF ARC LAMPS.

IN these days when much electrical machinery is being ordered from abroad, it is somewhat refreshing to be able to turn to a branch of electrical engineering in which, from the earliest days of the electrical age, we have excelled, and in which we still hold our own, having to a large extent been able to stave off the onslaught from abroad.

Manufacturers of arc lamps have had to face a serious competitor in the cheaply made foreign article. Many manufacturers quite outside the electrical industry have learnt to their cost the difficulty of competing with some of these cheaply made foreign productions, for though cheaply made they are often substantial enough to answer their purpose for the time being.

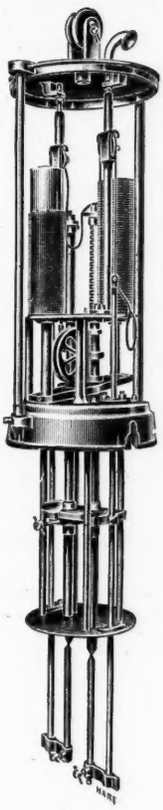


FIG. 1.

It can, however, be safely said that this competition has been satisfactorily met in the case of arc lamps; makers at home have appreciated the want of a lamp that can be sold at a reasonable cost, and have taken the necessary steps to meet the demand.

In this way foreign competitors have been kept largely at bay, and it is satisfactory to feel that the bulk of our home and Colonial trade is met by our own manufacturers.

From another point of view, however, the manufacture of arc lamps is interesting, viz., it is one of the few electrical productions which has been thoroughly standardised, and in which templates, jigs, and repetition tools form the most important parts of the plant.

At first sight it might appear that standardisation has been made easy by fewer sizes and types being required to meet everyday requirements than is the case in most other manufactures: to a certain extent this is true, though it must not be overlooked that at least three different types of lamp are necessary to meet these requirements, namely, a double carbon open type lamp, a single carbon open type lamp, and a long-burning enclosed type lamp, and that even these types are liable to slight alterations depending upon the burning conditions, and upon the fittings used. Consequently this standardisation has required a good deal of careful attention, and only those factories with a large output have been able to benefit in full by the many advantages gained by being able to work chiefly on stock orders.

The present article is intended to describe the chief features of these three types of lamp, and also to mention somewhat briefly the uses for which they are best suited. Due to most manufacturers confining their attention to one or two types of lamp only, it is often difficult to obtain an unbiassed opinion as to which is most suitable to fulfil certain conditions; this article describes the usual practice of Messrs. Crompton & Co., Limited, of Chelmsford, who make all three types of lamp.

Finally, doubt often exists, not only among users, but also among contractors generally, as to the most suitable fittings to use with different types of lamp, doubt as to whether internal or external cut-outs are preferable, and as to the advisability of using substitutional resistances under certain burning conditions, &c.

It is proposed to touch on these points, and to state the advantages and disadvantages of each system, mentioning at the same time that all-important matter, the approximate costs of the alternative methods. A search through the Patent Office abstracts, covering the last 25 years, gives one the impression that almost every conceivable device has at some time or other been patented in connection with arc lamps, and one feels that it is practically hopeless to attempt to bring out anything new.

Speaking more particularly of open type lamps, modern lamps are to a very large extent modifications of three or four distinct forms, and the type of mechanism is an almost certain indication of the country where the lamp was made. For instance, British manufacturers favour most the brake-wheel type of mechanism, whereas, on the Continent clockwork lamps are the most common, and in America lamps controlled by clutches are more numerous. The best known British manufacturers have made it a point to supply really well designed and substantial lamps, giving a delicate feed and costing little for up-keep, and that they have not failed in this may be gathered from the numerous very fine examples of street arc lighting to be seen in all parts of the kingdom.

Although the clockwork lamp of the Continent has been imported, it is in very few cases used for street lighting, or for other lighting under similar conditions. In America the enclosed lamp is used to a very much larger extent than in this country, taking the place of open-type lamps. There are reasons, however, to account for this. In that country the open-type lamp has not reached the same state of perfection as in this country, and less care has been given to its design, manufacture and running, so far as getting a perfect feeding of the carbons is concerned. The enclosed type of lamp, on the other hand, lends itself to cheaper manufacture, and so far as the feed mechanism is concerned, it can be more crude than that of the open type of lamp, owing to the slower combustion of the carbons. This is one of the reasons why it is so plainly stated in American literature that the enclosed arc burns more steadily than the open arc, but it should be added that this refers to the open arcs as made in America.

The result is that the enclosed type of lamp has made wider strides over there. In this country, where it has had to face well-made open type lamps, it has not made so much progress for street, dock, workshop, and similar lighting. For certain situations there is undoubtedly considerable field for enclosed lamps, but they are never likely to oust the British-made open lamps.

A few remarks only are necessary to show the stages through which the manufacture of arc lamps in this country has passed.

In the year 1878 Mr. Crompton brought over from Paris two "Serrin" arc lamps, at that time the only lamp that had been made in any quantity for practical use.

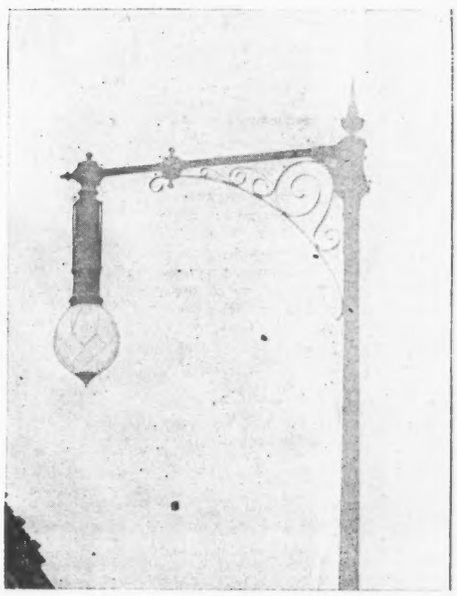


FIG. 2.

Directly after this, the end of 1878, or early in 1879, the first Crompton lamp was made, and it is an interesting fact that this lamp, which bears the number "1," is now in the possession of Messrs. Crompton & Co.

Various types of lamps followed, all being more or less of the clockwork type, perhaps the best known at the time being the "Mansion House" lamps.

This design, however, was soon modified, and a lamp of the brake-wheel type substituted, the best known of which was a

Crompton-Crabb "D D" and "D D 0" lamp, which we understand represented at that time quite a revolution in arc lighting.

These lamps were improved and strengthened from time to time, and it is a remarkable fact that many of them, made over 15 years ago, are still in everyday use, and giving such excellent results that they are not yet ready to be replaced by others of more recent manufacture.

We do not wish to imply that 15 years should represent the life of a good lamp, but a lamp made 15 years ago is a different thing to a lamp built to-day, when the designs and parts have been considerably simplified and strengthened.

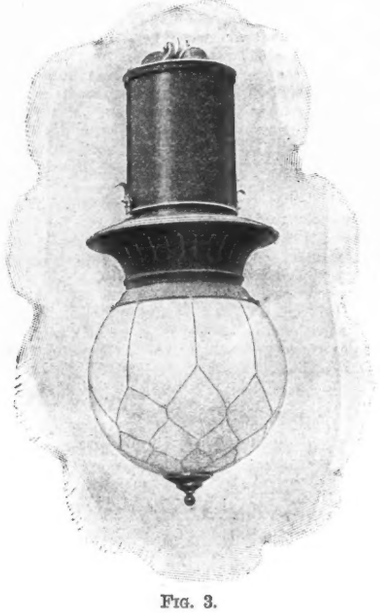


Fig. 3.

Paddington station is a good example of the satisfactory productions of the past, as the lighting of a railway terminus is naturally an important undertaking, and in the event of a single lamp failing, considerable attention is drawn to it.

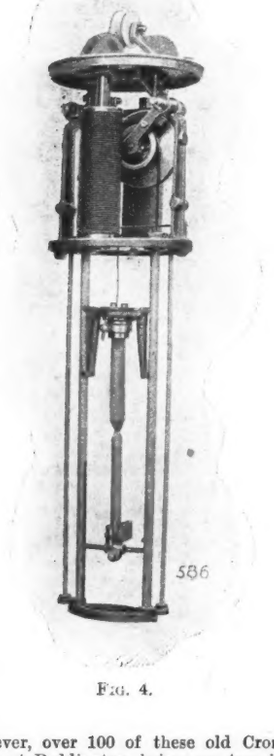


Fig. 4.

There are, however, over 100 of these old Crompton "D.D." lamps still in use at Paddington, being run two in series off an alternating circuit of 40 periods and 100 volts, and fitted with compensating coils.

They have been in use since June, 1887, and are likely to go on for some considerable time yet. Coming to more recent times, say the beginning of the nineties, one finds the chief type of arc lamp on the market to be an ordinary open type lamp, with one or two sets of carbons, arranged for burning 16 and 32 hours respectively.

This lamp, in Messrs. Crompton's case, took the form of the "Crompton-Pochin" "P" type, which is a rackrod lamp, and in which the principle or the brake mechanism of the older "D D" lamps was retained, though in the general design considerable improvements were effected. These improvements included the use of separate series and shunt solenoids each placed at the end of a rocking lever, the focussing of the arc, and the method of lowering the lamp from its top, which is a unique feature of the Crompton "P" lamp; general improvements in electrical and mechanical design were also introduced.

Fig. 1 shows one of these lamps arranged for double carbon burning and fitted with reflectors for alternating current. Fig. 2 shows a similar lamp, but arranged for single carbon burning, and with a patent insulated top, which enables the lamp to be rigidly suspended. This lamp was at first used to meet all the various requirements, such as street, factory, dock and shop lighting, and being a strong and well-built lamp it was well suited for these all-round purposes.

Due to the initial cost, however, of the lamp being somewhat higher than many installations would warrant, it was deemed advisable to introduce a cheaper type of lamp for meeting certain easier conditions, such as for lighting the interiors of retail shops, &c., and a few years later this took the form of the now well-known Crompton-Pochin "S" type band lamp. This lamp is shown in fig. 3, and the interior mechanism in fig. 4.

It was found at that time that many factories and shops would adopt arc lighting if they could buy a reliable lamp at a lower price, and consequently it was decided to introduce a pattern to meet this demand.

(To be continued.)

NOTE ON ALTERNATE-CURRENT DIAGRAMS.*

By W. E. Sumpner, D.Sc., Member.

Alternate current quantities can be represented by polygonal figures exactly as if they were forces. The length of the line represents the magnitude of the corresponding quantity, while its inclination denotes the phase. The phase angle between two lines is such that the cosine of the angle multiplied by the product of the lengths of the lines is equal to the average value of the product of the two quantities represented by the lines. The treatment of mechanical problems is often simplified by splitting up the forces concerned into components along perpendicular axes, adding the components, and compounding to find the resultant. Similarly many alternate current problems can be most easily dealt with by the separate consideration of the rectangular components of the quantities met with.

This process has been long known, and has been much used, in cases where it can be assumed that the currents and potentials vary according to a simple sine law. It has been proved by the present writer to be also perfectly accurate whatever the law of variation of the current. (See "The Vector Properties of Alternating Currents," *Proc. Roy. Soc.*, 1897, Vol. 61, p. 455.) The proof rests upon one fundamental proposition which was established in the paper referred to. A particularly simple proof of it, recently found, seems worthy of notice.

The proposition in ordinary language implies that the power factor of an alternate current circuit must be less than unity except for perfectly non-inductive conductors. More generally it can be stated thus:—

If x and y are two quantities varying with time in any way whatever (excepting the special case in which x is a constant multiple of y), the average value of the product of $x\,y$ is necessarily less than $\mathrm{X}\,\mathrm{Y}$ where—

$$\mathrm{X}^2 \text{ is the mean value of } x^2,$$

and—

$$\mathrm{Y}^2 \text{ is the mean value of } y^2.$$

To prove this, consider—

$$(\mathrm{X}\,y - \mathrm{Y}\,x)^2.$$

This quantity being a square is necessarily positive. Thus—

$$\mathrm{X}^2\,y^2 + \mathrm{Y}^2\,x^2 > 2\,x\,y\,\mathrm{X}\,\mathrm{Y}.$$

This being true at every instant, must be true also for the mean. Now X and Y do not vary since they are averages, also—

$$\text{mean } y^2 = \mathrm{Y}^2 \quad \text{by definition,}$$

and—

$$\text{mean } x^2 = \mathrm{X}^2 \quad \text{by definition.}$$

Represent the mean of $x\,y$ by $\overline{x\,y}$.

* Paper read at Birmingham Local Section of the Institution of Electrical Engineers, December 11th, 1901.

Substitute and we get—

$$2\,X^2\,Y^2 > 2\,\overline{x\,y}\,X\,Y,$$

or

$$X\,Y > \overline{x\,y}.$$

Thus if x is the voltage applied to a conductor and y the current through it, the product $X\,Y$ of the volts and amperes, as read by alternating-current instruments, exceeds the mean value of $x\,y$. In other words, the "power-factor" is less than unity. The only exception is when—

$$(X\,y - Y\,x)^2$$

is zero at every instant, or when—

$$\frac{x}{y} = \frac{X}{Y} = \text{constant}$$

for every instant. In this special case the power-factor is unity.

Even if the current does not alternate, but merely varies in some manner different from the voltage, the power-factor must be less than 1.

The proposition above stated is of very general application. It is not confined to the case of the voltage and current on a particular conductor. It is true of any two variable quantities. It shows that there is always some factor, f, less than unity, for which—

$$\overline{x\,y} = f \times X \times Y,$$

and f may conveniently be called the "product-factor" of the quantities x and y. The importance of the result is due to the fact that it really forms the basis of the method of representing alternating-current quantities by triangle diagrams, as it is possible to deduce from it that the well-known method is accurate, however great the variations from the sine law may be.

It may be noticed incidentally that the ordinary idea that it is possible to bring the power-factor of an inductive current up to unity by the use of compensators is erroneous. All that can be done is to raise the power-factor to a maximum value less than unity. The adjectives lagging and leading current, as applied to alternating currents, are convenient, but, though convenient, are not inaccurate. A current may be lagging when it is near zero, and leading in the neighbourhood of its maximum. The idea that the current if changed from a leading to a lagging condition must necessarily pass through a state in which the power factor is unity and the lag zero, is erroneous.

THE DESTRUCTIVE AND LETHAL EFFECTS OF HIGH-PRESSURE* CURRENTS.†

BY DR. MARGARET A. CLEAVES.

(*Continued from Vol.* 49, *page* 1094.)

FROM experimental evidence there is every reason to conclude that besides the influence exerted by the quality, duration, strength, and density of the current (Tatum) through the thorax, some other factor, apparently residing in the heart and probably physiological in nature, also exercises a considerable influence, as evidenced by the greater or less readiness with which the cardiac effect is produced (Cunningham).

Prévost and Battelli as a result of their very complete experimental work, arrived at the following conclusions:—

Conclusions and General Considerations.—Experiments upon animals, observations made upon the electrocuted criminals in America, the accounts of accidents occurring in the electrical industry, lead us, then, to conclude that according to all probability:—

1. The heart in man comports itself like that of animals; it is paralyzed in ventricular tremulations by a current of low pressure.

2. The death of man, in the accidents of the electrical industry, cannot be attributed to arrest of respiration considered as an immediate cause.

3. The death of man, in these accidents is due to the primary paralysis of the heart in ventricular tremulations.

4. Currents of high pressure, when the contacts are good and the heart lies upon the line which unites the electrodes, do not paralyse the heart of man; in this case the respiration is resumed, as has been observed upon the electrocuted criminals in America.

5. In the electrical industry the contracts are always more or less bad; for this reason the currents of high pressure act like currents of low pressure and lead to paralysis of the heart.

6. The difference in the results (mortal or not) of the grave accidents of the electrical industry can be explained in two ways; we must assume that the duration of the contact has been too short (fractions of a second) and that the heart has not been placed in ventricular tremulations; or we must admit that the paralysis of the heart of man is not always decisive, *i.e.*, permanent.

From these conclusions it would appear that in employing a current at high pressure, for the purpose of electrocuting a man, we have secured a result quite different from that which we set before ourselves to obtain, viz., to kill the man rapidly.

The study of the ventricular tremulation of the heart which hitherto has offered only a theoretic interest, now assumes some practical importance; for it is to the development of these tremulations that are due the mortal accidents in the electrical industry. The physician, in most of these accidents, is quite impotent, for we possess no *practical* means of re-establishing the beats of the paralyzed heart. Artificial respiration, absolutely useless in the case of well-defined paralysis of the heart, can be sometimes of some use if this paralysis is transitory, in facilitating the normal resumption of the respiration. In any case, artificial respiration is actually the only treatment which the physician has at his disposition.

Cunningham, in his experiments, reached practically the same conclusion, at about the same time as, and independently of, Prévost and Battelli. The evidence obtained as a result of his experiments upon a series of 30 dogs is most conclusive, and his work, after a lapse of two years, may be regarded as classic. In view of this fact, a somewhat detailed description of his technique, as well as of the results which he obtained, is of sufficient importance to warrant us in publishing it in the present article.

A medium-sized dog was etherised, and into the right carotid artery there was inserted a cannula, which was connected with a Ludwig manometer. The latter in turn was so arranged that the pulsations should be recorded upon the paper of a Hürthle kymograph. A second cannula was introduced into the trachea; and through this the anæsthetic was administered when necessary. As a third step the hair over the chest was carefully removed by shaving, and the scalp and soft parts covering the skull and temporal fascia (on both sides) were dissected off. Then, finally, the contacts, covered with thin chamois skin, and well wetted with a strong, hot saline solution, were applied to the two regions thus made ready for them; to that of the heart a plate electrode, connected with the negative terminal and held securely in place by means of strips of rubber plaster; to that of the head a cup-shaped electrode connected with the positive terminal. A stethograph was attached to the chest and connected with a recording Marey tambour. A chronograph placed in shunt with the circuit that passed through the dog served to inscribe the base line of the tracings as well as to mark the closing and the opening of the circuit. A second chronograph indicated the time in two-second intervals, while a Whitney dead-beat voltmeter and a Weston dead-beat ammeter were used to measure the pressure and the strength of the currents. Normal tracings of the blood pressure and the respiration were first taken and then the circuit was suddenly closed and kept closed for 76 seconds. During its closure there was observed a pressure of 116 volts and an observed current of 0·4 ampere. The following effects were noted: Almost simultaneously with the closing of the circuit the blood pressure rapidly fell to zero, the tracing showing a few heart beats—auricular. At the closure a deep inspiration was produced, then there was a deep expiration, followed by cessation of respiratory movement in a state of expiration so long as the current continued to pass. On breaking the circuit a deep inspiration followed by an expiration resulted, and after a few moments a few shallow respirations were observed. Artificial respiration was then begun and was continued without avail for 20 minutes.

The occurrence of natural rhythmical respiratory movements after the opening of the circuit demonstrates that the respiratory centre in the medulla is not paralyzed nor instantly killed. Further, the tracings show that an almost total and instantaneous extinction of the arterial circulation is produced. By opening the chest previously and observing the behaviour of the heart, it is readily demonstrated that this extinction of blood pressure results from a practically instantaneous cessation of the co-ordinated rhythmical movements of the heart at the instant that a current of 0·9 ampere or even less is passed through a dog. Both ventricles immediately stop beating, while the auricles, especially the auricular appendages, beat with extreme rapidity. On stopping the current the auricular appendages generally resume their usual co-ordinated rhythmical contractions, which may often continue for a considerable number of minutes. Frequently the auricles will begin to beat again co-ordinately for a few seconds, but the ventricles rarely if ever exhibit the slightest sign of co-ordinated contraction. Cunningham noted ventricular contraction in only a single instance, and that only after he had introduced a tube into the jugular vein for the purpose of withdrawing venous blood from the greatly distended heart. This points to a direct action upon the ventricular portion of the heart muscle. The only difference observed, when the points of contact are the chest and fore-leg, instead of the head and chest, is the greatly exaggerated respiration shown by the resultant tracings. Upon opening the thorax immediately after the passage of the current through the heart percutaneously, a careful examination of the still quivering ventricles shows that the co-ordinated beat of the heart is absent, as a whole, while the various minute bundles of muscle fibres alternately contract and relax with considerable vigour in various parts of the ventricles. As the right cavities of the heart become more and more distended by the accumulating venous blood, the asynchronous quivering of the various little bundles of muscle fibres grows less and less until finally every trace of muscular contraction disappears from the greatly distended ventricle. The action of the current, Cunningham concludes, produces upon the heart the well-known phenomenon described by physiologists as *delirium cordis* or *fibrillar contraction*, "supposed to be caused by some change in the muscular fibres themselves," and Hedley* asks: Is this a coagulation by the heat, resulting from the tetanic muscular contractions?

Cunningham believes that there is no question of the instantaneous death of the muscle cells of the heart nor of their paralysis, nor of

* In every instance in which authorities quoted have used the word "tension" in relation to an electric current, the writer has substituted "pressure," in order that the terminology may be exact.

† *Handbook of the Medical Sciences. (U.S.A.)*

* "The Pathology and Treatment of Electric Accidents." Londo *Lancet*, August 25th, 1894.

profound molecular changes invisible under the microscope, resulting from the direct disruptive action of the current. This, he says, is readily proved if Porter's method, or any other method for recovering the excised dog's heart from the condition of fibrillar contraction, is employed. By the use of Porter's method (perfusion of the blood-vessels of the heart with warm defibrinated dog's blood diluted with 0 8 per cent. saline solution) the excised hearts (still manifesting fibrillar contractions) of numerous electrocuted dogs were made to beat co-ordinately again and to continue their co-ordinate contractions for nearly an hour, only ceasing then because of the discontinuance of artificial respiration. It was often necessary to plunge the excised hearts into iced saline solutions in order to stop all movements before co-ordinate beats could be established. These facts demonstrate that the heart muscle is not paralyzed or killed by the current; for if it were paralyzed no movements would have been observed after the passage of the shock; and if the muscle had been killed no recovery could have occurred on restoring the circulation. It is probable that "the effect of the electrical stimulus has been to disturb the balance of the hypothetical intracardiac co-ordinating mechanism, the nature and location of which physiologists are still endeavouring to elucidate."

Cunningham points out, as did Prévost and Battelli, that it is well known that the action of various kinds of stimuli upon the exposed mammalian heart—for example, mechanical, chemical, electrical,* and also the stimulus of cold—produce the condition known as fibrillary contraction; consequently the effect is physiological in nature and not one that is characteristic alone of the passage of an electric current.

In view of the fact that an electric current produces this effect upon the exposed heart, it is not at all remarkable that a strong electric current, continuous or alternating of a moderate frequency, when passed percutaneously, should throw the heart into a condition of fibrillar contraction.

H. Dixon Mann concluded, from the phenomena observed as a result of percutaneous applications of the continuous current upon man, that a struggle takes place between the natural and the artificial electrotonic conditions; and that when the heart is weak and the current strong, the heart is overcome, but that when the organ is fairly strong and active it is able to bear the force of the current without experiencing any harm.†

The experiments of Cunningham, as well as those of Prévost and Battelli, are conclusive in showing that death in dogs—and without doubt also in man, in view of the evidence of autopsies—from low-pressure currents (120 volts), or from those of medium pressure (240—600 volts), or even from currents of high pressure (above 600 volts), when the conditions of the circuit are such as to cause a high-pressure to act as a low-pressure current, is due to the excitation of fibrillar contractions from which the heart of the mammalian rarely recovers. The fact that certain animals (frogs and turtles, for example) recover easily from such a condition explains why they are not easily killed by low-pressure currents, and that to cause death, in these animals, the production of asphyxia by the use of high-pressure currents would be necessary.

In determining the action of a strong continuous current upon the cranio-cervical portion of the nervous system, Cunningham placed the contacts directly upon the exposed brain and spinal cord, thereby minimising the resistance and acting directly upon the nerve centres. The passage of a current of 1·1 amperes for one minute directly through the cerebrum, medulla, and upper cord resulted in the usual deep inspiration followed by expiratory standstill, while the current was still flowing. If the current was not kept applied for too long a time, the respiratory movements generally recommenced a few moments after its removal. At first these movements were feeble, but gradually they resumed their normal rhythm, if the electrode had not been pressed with undue force against the brain. Even when the dose was 1·6 amperes, after the current had been on for several seconds, respiratory inhibition was overcome and pronounced respiratory movements began while it was still flowing. As a rule, however, inhibition of the respiratory centre during contact was maintained by a current of 1·5 amperes.

The blood pressure behaves differently when the contacts are directly against the brain and spinal cord, from what it does when they are placed simply against the head and chest:—*i.e.*, after a slight rise coincident with the general tetanic spasm of the muscles, produced always by the closure of the circuit, the pressure falls slightly; it then rises to a considerable height, often twice or thrice its original height, if the circuit is kept closed for 50 seconds. If the current is broken at this time it may or may not continue to rise for a few moments, but after this it quickly returns to the normal. On the other hand, if the flow of the current is continued for four or five minutes the blood pressure slowly diminishes, the cardiac action becomes progressively more laboured and slower, and finally ceases. If artificial respiration is maintained, this enormous rise in the pressure does not take place. If the current is discontinued after the lapse of a minute, the inhibited heart action gradually disappears and respiratory movements, at first slow, soon become natural.

The asphyxia from inhibition of the respiratory centre appears to be mainly responsible for the increased blood pressure.

These experiments demonstrated the ability of a strong, continuous current passed through the brain and upper part of the cord to kill; but that the mode of death is quite different from that which takes place when the heart lies in the conducting path and is traversed by the current. In the former the lethal effect is plainly the result of asphyxia due to a respiratory inhibition, while in the latter the lethal result, even from moderate currents continued for a short period, is due to the permanent stoppage of the heart's co-ordinated action, the central nervous system dying from anæmia.

(To be continued.)

* Weber, Ludwig, and Hoffa, for magnetic electric currents: Einbrodt, Mayer, Herbst, and McWilliams for continuous currents from batteries and small induction coils. All of these authorities are cited by Cunningham in his treatise.

† "Action of Electric Currents on the Heart in Living Subjects."—The phenomena have also been observed by the present writer in therapeutic administrations of a continuous current when the heart was the subject of disease—mitral insufficiency—and the dose was increased beyond the tolerance of the patient. The symptoms were anguish, præcordial distress, and threatened syncope, with an irregular and feeble pulse. In view of the action of oscillatory currents of high potential previously alluded to, it is interesting to note that relief was promptly established by a general application of the convective discharge from a large influence machine with a localisation directly over the heart and to the dorsal spine.

THE AQUARIUM EXHIBITION.

For many months past we have been receiving intimations of elaborate preparations which were to be made at the Royal Aquarium, Westminster, for the Twentieth Century Electrical Exhibition. The show is now in progress, and those of our readers who choose to do so, and want to while away a happy hour, or go "prowling," as at least one of our contemporaries has done, may see for themselves the brilliant result of this enormous effort. Were we to review the Exhibition from the preface to the catalogue, we should say that the "strides made in electrical progress within the last few years are well exemplified in the Twentieth Century Electrical Exhibition," and that "there is no doubt that a visit to the Exhibition will be both interesting and instructive to everyone connected with the electrical trade." But that we do not propose to do. Now, we are of opinion that even the Glasgow Exhibition only just "well exemplified," &c. The Aquarium show in progress cannot even claim to be an aftermath of that, as some of us expected it might be, and it certainly is only in the smallest degree representative of recent progress. But we do not quarrel with the Exhibition itself; rather do we wonder why ever such a place as the Aquarium was fixed upon for an electrical exhibition, which is generally a place for doing business, and not whiling or "prowling."

The stands in themselves are pretty well arranged as a whole, but the attendants at those which are located—as most of them of necessity are—around the "variety entertainment" stage and water-butt, find life to contain more of the comic element than serious business.

Having said thus much let us proceed to summarise the electrical apparatus and fittings with which the electrical trade is to be instructed, and to see which it is whispered Victoria Street consulting engineers went over *en bloc* just after the Exhibition was opened.

Messrs. Hedges, McKrell & Taylor have a small show of various electric light fittings, measuring instruments, switch work, and accessories. Messrs. Pritchetts & Gold have a good exhibit of their secondary batteries and an electromobile; the batteries include their positive cast plate, with corrugated rib to prevent buckling, which has been on the market for the past 18 months. The electromobile is run by 40 of their pasted plate cells. The D.P. Battery Company, Limited, of Westminster, have an excellent exhibit of their latest batteries, for some of which new features are claimed. The Lowne's patent new household electric clock, which never wants winding or oiling, is shown by Messrs. R. M. Lowne and Sons, of Catford; the same firm also exhibit their patent electric wind vane for recording the velocity and direction of the wind. A small and strong outdoor transmitter automatically records the changes upon the indoor dial by means of a small battery. We understand that in the Lowne invention provision is made for automatically reducing the period of the electrical transmission to a unit of time, irrespective of the slowness or quickness of the movements of the vane. The instrument denotes eight points of the compass, and requires only five small wires from the transmitter to the dial. Messrs. Nunn, Watts & Co., of 82, Mark Lane, who are consulting marine engineers, and also electrical installation contractors, and do a good deal of electric ship lighting, have some of their electric light and heating apparatus and fittings, and telephone and bell appliances on view. Messrs. Geipel & Lange, of Westminster, show their well-known steam traps, steam separators, Ward Leonard rheostats and circuit breakers, the Vulcan motor meter, some small motors, centrator gearing, and okonite and Manson tapes. The Bristol Electric Safety Lamp Works have their portable lamps, and non-spilling pocket accumulators in evidence. The Acme Motor and Traction Company show two or three of their small motors for cars and launches, one of these doing service to drive a sand-blasting apparatus shown by Mr. M. de Leon. The "Simplex" conduit system is, of course, exhibited by the Simplex Steel Conduit Company. A variety of candelabra and other lighting fittings are shown by Messrs. W. Sitch & Co., of Berwick Street, W.

One of the largest exhibits is that of the Consolidated Telephone Construction and Manufacturing Company, where an excellent collection of British made telephone apparatus is to be seen, also switchboard apparatus made by their Williamson & Joseph works at Canonbury. The Long-Schattner Electric Meter Company are exhibiting their electric prepayment meters as approved by the Board of Trade, also accumulator charging meters, the Atkinson-Schattner demand indicator, and the Schattner standard meter. The Bastian Meter Company are in evidence with their meters, also approved by the Board of Trade.

Other shows which we may mention are Messrs. Harry W. Cox's large induction coils, of the manufacture of which he has long made a speciality; the Renewable Lamp Company's stand where, as at many other exhibitions, their interesting operations are shown in progress; the Gardner electric drill shown by the Gardner Electric Drill and Hammer Company, Limited, of Moorgate Street, E.C., this being driven by the Cassell self-regulating waterwheel for which power is obtained from the water main in the building; some "New Century" arc lamps, by the New Century Arc Light Company; electro-medical appliances by the Excelsior Electric Company; electric heating appliances by the Crown Electric Heating Company, of Bury Street, E.C.; insulating materials by Wilkins, Campbell & Co., of Mincing Lane; rock drills by the Ingersoll-Sargeant Drill Company.

Messrs. Vandam have a very large and well-arranged assortment of electric lighting accessories, such as switches, fuses, incandescent lamps in many fancy shades and shapes, their new combined fuse and switchboard, their 25-ampere H.V. switch, whose main point is the absence of any metal parts from the back; also measuring instruments and hundreds of things required in electrical installation work. Messrs. Foxcroft & Duncan, of Dalston, exhibit their "Sappho" enclosed arc lamps, "Phœnix" arc lamps, "S. S." arc lamps, gravity measuring instruments, and other specialities of their manufacture.

Electrical illuminations will be all the rage directly, and in view of the approaching coronation ceremonials and festivities, electric lighting firms will be booking a good deal of business of this description. The E.L.B. Company, whose system is quite familiar to our readers, make a brilliant show on the Aquarium fountains, their work being done by four men in the short space of only two days. The stall of Messrs. Vandam & Co. is in part illuminated by Bank's patent electric lighting surface board. The O.T.B. system, as it is called, has for its main principle a prepared surface, the interior of which is arranged with metallic conductors and specially protected against damage by bad connections or damp. These conductors are arranged in such a manner that, by pressing the lamp or plug into the surface as far as it will go, the desired illumination is obtained. The lamps, globes, or plugs are arranged with spikes attached for inserting into the surface or cushion.

Some electric signs are exhibited by Messrs. Taylor & Co., of Berners Street.

Demonstrations and lecturettes on Marconi wireless telegraphy and the Tesla coil are among the items in the programme of Aquarium attractions, Mr. W. Lynd being the lecturer.

CURRENT SPECIFICATIONS.

LXXXVII.—WEST BROMWICH TRAMWAYS.

SUMMARY.

Extent of Contract.—Reconstruction and electrical equipment of tramways within the Borough of West Bromwich.

Division of Contract.—Five sections:—(1) Supply of rails, tie-bars and points; (2) road work and rail bonding; (3) supply and erection of trolley poles; (4) bonding and overhead work; (5) supply and laying of feeder cables.

Amount of Rails, &c., Required.—2,000 tons of steel girder rails, 11,000 tie-bars, and 3,000 of Cooper & Howard Smith's patent joints.

Tensile Strength of Metal.—Not to be less than 40 tons per sq. in. with an elongation of 15 per cent. in a length of 8 in.

Length of Rails.—Ninety per cent. 45 ft. long, 10 per cent. not less than 30 ft. long.

Rail Joints—To be Cooper & Howard Smith's patent in accordance with drawing supplied.

Points, Crossing and Drain Rails.—To be supplied in numbers as specified.

Roadwork and Rail Bonding.—About 12 miles of track measured as single track to 3 ft. 6 in. gauge to be laid in certain specified roads.

Quality of Cement.—To comply with specified tests and requirements.

Quality of Wood Blocks.—To be of best quality "Jarrah" or "Karri," in blocks of specified size.

Quality of Granite Paving Setts.—To be "Mount Sorrell," or other approved quarry.

Number of Trolley Poles.—446 in all, of three grades—8 of Class A, 190 of Class B, and 248 of Class C; Class A being for use as terminal poles, Class B for span-wire poles, and Class C for centre poles.

Bonds.—To be of four different lengths, and either of "Neptune" or "Columbia" type.

Trolley Wire.—To be equivalent in sectional area to 000 standard wire gauge, not less than 95 per cent. conductivity.

Overhead Construction.—Tenders will be accepted for one or more of three classes of insulators, one of these classes, viz., "B," not being applicable to span-wire construction.

Types of Insulators.—Class A.—Gun-metal metal parts; insulation, any type other than that of red fibrous nature. *Class B.*—"Fylde" insulating bushes to be used, made by Mr. J. B. Smith, 5, Blakiston Street East, Fleetwood. Only suitable for centre-pole construction. *Class C.*—"Quin's" patent insulators with gun-metal fittings, made by Grant's Drill and Trolley Company, Ince, near Wigan.

Section Boxes.—Each to contain two of "Quin's" patent safety switches, as made by the British Insulated Wire Company Limited.

Feeder Cables.—To be of specified sectional areas and lengths, paper insulated, lead covered, laid on the solid system in socketted earthenware troughs with earthenware lids manufactured by the Albion Clay Company, Limited, or other approved makers. The filling-in material to consist of a mixture of sand, Stockholm tar, and resin boiled together in the proportions specified.

Specified Dates of Delivery and Completion.—All at times and in quantities detailed in the specification.

Penalty for Late Completion.—One half of 1 per cent. of contract sum per week.

Terms of Payment.—Up to 80 per cent. of value of work executed during progress, 10 per cent. three months after acceptance of work by Corporation, 10 per cent. three months later.

Period of Maintenance.—One year from date of acceptance of work by Corporation.

Stipulations as to Removal of Foreman.—Satisfactory.

Stipulations as to Wages to be Paid to Workmen.—Acceptable, see comments below.

Liability for Night Work.—See comments below.

Arbitration Proposals.—Satisfactory.

Date for Receipt of Tenders.—January 17th, 1902.

This specification is signed jointly by Mr. A. D. Greatorex A.M.I.C.E., the borough engineer, and Mr. R. C. Quin, M.I.E.E., M.I.M.E., the consulting engineer to the Corporation, and asks for the supply, laying, and erection of about 12 miles of single track of tramways to be worked on the overhead trolley system. It will be noticed from above summary that the contract is to be tendered for in a number of different sections, and we strongly advise all tenderers to very carefully study the wording of the specification before filling in their contract figures.

In several sections the contingent liabilities require careful consideration; thus in Sections 2, 3, 4 and 5, the successful tenderer may be called upon, at the engineer's option, to carry out any portion of the outdoor work at night *without any addition to the contract price.* We consider this unfair to both parties to the contract, for none will deny that the cost of doing the work at night will be higher than during the day. It is open to the engineer to demand that any part he likes of the work shall be carried out under these more expensive conditions. If the contractor covers the whole risk in his tender, the Corporation may pay more than is necessary, while if the contractor has not thus covered the risk, it is unfair to him. In the same way, while in all sections but Sec. 2, the period of maintenance against defective workmanship and material is *twelve months*, and for Sec. 2 *six months*, responsibility for any accident which may occur through the negligence of the contractor or not, is in Clause 18 expressly stated to be for a period of two years from the date of acceptance of the work.

It would also be advisable for tenderers to stipulate that the date of acceptance by the Corporation, on which the dates for the second and third payments, as well as the dates for free maintenance depend, should coincide with the opening of the line for public traffic, or else it might be possible under Clause 27 to defer payments to the contractor even while the line is in beneficial use by the Corporation. The arbitration clause, though ample in other directions, does not provide for this contingency.

But our most serious cause of complaint against the manner in which the specification has been prepared lies in the repeated demands for special articles, to the exclusion of other appliances possibly quite as good. No one can read our summary without noting instances in which specially patented articles are asked for and the names of the manufacturers are given, while it would appear that in several cases the patentee is one of the engineers responsible for the preparation of the specification. We protest strongly against any such limitation of the right of a tenderer to choose his own way of meeting the requirements of a specification to which he tenders. In our opinion it is the function of a consulting engineer to specify as clearly as he can the results he wishes obtained, leaving it open to manufacturers to make their own proposals as to how these ends are to be attained.

We are glad to know that it is a most unusual feature in modern specifications to find an absolute demand for articles patented by one of the engineers responsible for the preparation of the same.

HIGH SPEED STEAM ENGINES.*

BY JOHN DAVIDSON.

MUCH has been written in the technical journals, and many papers have been read before the various mechanical and electrical institutions of Great Britain, on this subject during the last few years; and in almost every article or paper some particular type of engine has been described as the best and most suited for doing its work when running at a high speed of rotation. In the paper which you are about to have read to you to-night it is intended to deal, gene-

* Paper read before the Liverpool Engineering Society on December 4th, 1901.

rally, with engines of the quick revolution type, setting forth—as truly as can be expressed—the advantages they possess over engines of the slow speed, or more correctly speaking, slow revolution type.

The enormous demand for engines to drive generators for electric light, power and traction purposes during the last 10 to 15 years has led to the development of quite another type from that in general use even 10 years ago, and has brought about quite a revolution in engine building.

Electric generators were first driven by engines of the slow revolution type through gearing—either ropes or belts, &c., but this arrangement is now in almost every case superseded by engines coupled direct to the generators, the majority being engines of the quick revolution type, and thereby the losses due to the intermediate gearing, viz., ropes or belts, have been entirely dispensed with. This means economy in steam consumption, space occupied, and initial outlay for plant. Of course engines for electrical work are not the only ones built of the quick revolution type, as engines have been constructed for many years past, and many are in course of construction, for driving propellers for torpedo boats, &c., where it is absolutely necessary to get the maximum power with the minimum weight of machinery. Engines built for this class of work are of the most excellent design, and the best material possible has been used in the construction of the same, and the author thinks he is safe in saying that the want of extremely quick revolution engines for torpedo boats has led to greater development in design of this class of engine, more even than in those required for electrical work; but there is one difference, and that is, engines for electrical work have to be able to work at their highest speed continuously, whereas engines for torpedo boats have only to work for short periods at full speed.

Again, engines of the quick revolution type are now not only being used for driving electrical generators, &c., and for torpedo boats, but are being adapted for every class of work for which engines are used, viz., for driving machine shops, cotton mills, paper mills, &c.

The development of the design of quick revolution engines has not been of mushroom growth, and the present examples of high class engines of this type are the result of many years of thought and labour by the leading quick revolution engine builders of the present day.

It may seem to many at first thought that there is nothing difficult or marvellous in making an engine run satisfactorily at, say, from 400 to 500 revolutions per minute, and to develop, say, from 100 to 150 H.P., but to do this satisfactorily has necessitated many alterations in the details of engines as made for running at slow speeds of rotation; but this is history.

The quick revolution engine has long since proved to be a success, and has come to stay, and for electric light and power, the speed at which the engine should revolve is now limited, in most cases, by the builders of the generators, and not by the difficulties expected due to high speed in the engine itself. Engines of the quick revolution type can be thoroughly relied on, and the wear of all parts has proved, after long experience, not to be excessive. An increase in speed in engines has been found to develop many advantages in the way of economy in steam consumption—this economy increasing as the speed increases. Some disadvantages, or what might be described or imagined as such by many people, are, of course, developed, but these are out-balanced by the advantages developed, so they really cannot be taken into consideration.

The first in the field, or the first to develop an engine of the quick-revolution single acting type to run satisfactorily, was the late Mr. Willans, but since then many firms have joined in the game and are succeeding in building engines of the double-acting type.

Among the most important of those who have taken up the development of the double-acting type of engine must be mentioned Messrs. Belliss & Co. and Messrs. Browett, Lindley & Co., Messrs. Belliss truly being the pioneers of the forced lubrication type of engine.

One of the greatest troubles some engineers think will be developed with quick-revolution engines, or which will have to be overcome, is to be able to get the valve gears to work satisfactorily when running at anything over from 90 to 100 revolutions per minute; but engines of all powers have been made to work satisfactorily at much higher speeds when fitted with slide and piston valves driven by simple valve gears, and with this class of gear there can be no question whatever as to durability of mechanism if thoughtfully and carefully designed, and with large bearing surfaces provided at various points.

There is another type of engine, which the author does not propose to deal with in this paper—viz., the steam turbine—connected with the development of which the name of the Hon. Charles Parsons will ever live. With this type of engine it seems there is hardly any limit to speed of rotation. The developments in this direction during the last few years have been something wonderful, and most certainly there is a great future for the steam turbine.

One of the questions which must present itself to everybody is: Why run engines at high speeds of rotation, and what are the advantages to be gained by doing so? What is wrong with the slow revolution engines fitted with, say, Corliss trip gear, with their beautiful and fancy mechanisms, with numberless joints and links, guaranteed to cut off in a very small fraction of a second, and make a pretty indicator diagram? Surely not only to obtain a square corner on the indicator diagram, and certainly not for cheapness. Again, the majority of slow revolution engines are of the horizontal type. Why should we not have kept to this type of engine?

Some of the advantages claimed, say, for the famous Corliss slow-revolution type of engine are:—

(*a*) Perfect drainage of cylinders (with horizontal engines), and separate ports for steam and exhaust, and these, the author maintains are the only great advantages.

(*b*) Small clearance volume in cylinders.

(*c*) Beautiful steam distribution, and

(*d*) Separate ports for steam and exhaust.

(*e*) Easy to get at and lubricate, being all near the ground floor

(*f*) Automatic expansion made easy.

Against these may be placed some disadvantages, viz.:—

(*a*) Four valves to each cylinder.

(*b*) Enormous number of joints with the Corliss type of gear, all wanting lubricating and keeping in repair.

(*c*) Cylinders wearing oval in the horizontal engines which give the perfect drainage.

(*d*) Great floor space for power developed.

(*e*) Expensive foundations and buildings.

(*f*) Bad turning effort, excessively heavy fly-wheels being necessary, in many cases, to keep the angular variation within the necessary limits, especially for electrical work.

(*g*) Great amount of labour for running engines of this type, so many joints having to be lubricated by hand, &c.

(*h*) Expense of repairs; so many joints to keep in order.

For consideration, we will place side by side with this list the various advantages and disadvantages of an enclosed quick revolution engine of modern design:—

Small space occupied.

Lightness.

Reduced cost of engine, and, when coupled to an electrical generator, reduced cost of generator also.

Great saving in cost of foundations and buildings.

Reduced initial condensation in cylinders due to short time of exposure of cylinders to temperature of exhaust, and consequent gain in economy.

Less area of surface exposed, reducing losses due to radiation.

Very simple valves and gears.

All working parts automatically lubricated.

Very little labour required for the management and running of engines.

Very little wear, owing to perfect system of lubrication, &c. which cannot be adopted with an open type engine.

The disadvantages which might be imagined may be summarised as follows:—

Large clearance space and loss of economy thereby.

Great wear and great liability for the various joints to knock due to the sudden reversals of stresses in double-acting engines.

Vibration.

Frequent adjustments which one might think necessary.

Having just noticed the various advantages and disadvantages of both types of engines, and assuming the above list of these advantages and disadvantages, for the present, as correct, you will agree with the author—for the time being, at any rate—when he says that the quick revolution engine must be the favourite, for it appears that it is the most economical, requires the least repairs, and is the cheapest engine.

One of the most important questions here arises—What speed can an engine be safely run at? What is the maximum speed it is possible to design an engine to run? Taking the proportions of engines as now built as standards by the leading quick revolution engine builders, it appears on the face of it that speed can very easily be put up considerably without leading to trouble, these engines being capable of running for weeks, and in many cases, months, without being shut down; and speaking generally it is not even necessary to make any adjustment whatsoever after an engine of this type has been running for six months without stopping (note example given later). The advantages of quick revolution engines having thus been taken for granted, why not increase the speed of engines still more? In Table I. the author gives a list of speeds of engines of various powers which are about an average of present day practice:—

Table I.

I.H.P.	Revs. per minute.	Piston speed.
50	550	475
100	500	500
150	450	600
200	400	600
300	375	625
400	350	650
600	325	700
1,000	300	700

If these engines have thus gained advantages by running at the present speeds, greater advantages may naturally be expected by running at the higher speed. To consider this we must look into the matter in detail. Taking an engine, say, of a two-crank compound type of 500 I.H.P. as having, say, 12 in. stroke, and running at 350 revolutions per minute; what is to prevent this engine being run at 450 revolutions and still giving 500 I.H.P.? Leaving the stroke the same, the cylinders would be reduced in diameter, but the piston speed would be increased to 900 ft. per minute—being rather high for present day practice in connection with quick revolution engines, but even this is reached in many slow revolution engines; so why not have it here? The increase in speed, however, has many effects, and has a limit independent of wear; one effect it has is on the ports, as these must be of larger area to admit the steam to the cylinder and so increase the clearance volume; also the inertia of the parts is increased as the square of the speed; as we require less parts to give the same power when running at the higher speed the weight will be decreased, but, unfortunately, not *pro rata*; so in the inertia effects we have a limit. Up to a certain speed the inertia of the reciprocating parts has an equalising

effect upon the pressure on the crankpin, and consequently upon the turning effort of the engine, but beyond that speed trouble begins to arise due to shocks and vibration, unless the parts be thoroughly balanced. To overcome these difficulties the weight of the parts must be lightened and the best materials possible used to ensure the necessary factor of safety in all parts under stress. Of this kind of work we have some of the finest examples in engines built for torpedo boats.

Assuming then that in the inertia effect caused by the weight of the reciprocating parts, we have a limit, even with the reduced cylinders, which, of course, means that we cannot exceed a certain piston speed; the next question to deal with is the stroke of the engine, which, again, at the same time, also lightens the parts, and therefore reduces the effects of the inertia. It would be a most interesting point to find where the limit will be to the speed of rotation with reciprocating engines, and to what extent the stroke may be reduced for a given power. As engines are now designed and are made as standards by the present builders of quick-revolution engines, they have not reached a limit in either of these directions. The piston speed of engines built for torpedo boats reaches 1,200 ft. per minute, and for short periods, at any rate, engines can be run at this speed satisfactorily. With special lines and pistons, &c, what is there to prevent us from building engines with very short stroke with the piston speed reaching 1,200 ft. per minute? And it may also be mentioned that the stroke has not yet been reduced to such an extent as to bring the crankpins to appear as eccentrics on the shaft.

Single and Double-Acting Engines.—When quick revolution engines were first introduced, it was claimed that the only engine suitable for that purpose was one of the single-acting type with constant thrust. With this engine no reversal of stress in the parts—and, consequently, no lost motion and no knock—appeared. On this account it was maintained, and no doubt correctly, that there would be less wear in the journals and crank-pins than in a double-acting engine running at even half the speed; and when the system of forced lubrication was first adopted by a well-known firm it was referred to by one engineer of repute as an ingenious and bold attempt to evade the natural difficulties which the case presents; but was it not a proper means to an end? Does not building a single-acting engine for the sake of running at high rotative speeds rather seem a round-about way of achieving this end? At the same speed, twice the volume is required in the cylinder of a single-acting engine to give the same power as that of a double-acting engine; and, therefore, unless you build tandem engines—which leads to great complications—very much space is required; but, nevertheless, thousands of single-acting engines are in use, and hundreds in hand at the present time, and they certainly run quietly under load, if properly built, and will not knock until they tumble to pieces when worn out. Regarding single-acting quick revolution engines, and whilst speaking of them running quietly and not giving trouble, the author would here like to repeat a little conversation which took place between two well-known engineers some years ago; this he quotes from a paper given in 1895. One gentleman, when discussing the Willans engine, said, "I really do not know what there is inside a Willans engine, but I know there are three holes in it: one hole where the steam goes in, another where the steam goes out, and another where you put the oil in; and if I only pay proper attention to these holes everything will go all right." This the author quite believes, as he himself has stood by some of the Willans engines and could hardly tell that they were running without looking at some revolving part outside the engine. But he has also stood by a double-acting enclosed forced lubrication engine running under load, and could hardly tell that this engine was running. Therefore, it seems possible to the author that a double-acting engine may be made to run as silently as the single-acting; and, power for power, only half the size.

Let us look into the question of single-acting engines a little in detail. A single-acting engine is one in which the power is transmitted from the piston in one direction only, which, in a vertical engine, for various reasons, is always a downward direction; therefore, the crankpin gets a push on the down-stroke, and has to lift the parts on the up-stroke, these parts during that portion of the travel doing nothing; in fact, tending to retard the speed of rotation of the crankshaft. What is the use of causing a piston, which must be twice the size of that of a double-acting engine, to traverse twice the distance necessary to do a given amount of work? This leads to a point which is often ignored, viz., the mechanical efficiency of a single-acting engine. Is it possible under these conditions to obtain the same mechanical efficiency with a single-acting engine as that of a double-acting? In the double-acting type we have pressure on the pins and bearings both on the up and down-stroke, due to the pressure of the steam on the pistons, and transmitting power to the crankshaft. Due to this pressure, there is a certain amount of friction in all the bearings of the engine. In the single-acting engine we have pressure, due to the steam on the piston doing work on the down-stroke, and pressure on the bearings on the up-stroke, due to compression or the air cushion to keep the parts in constant thrust; during this period no work is done. At the lighter loads on the engine we have very light pressures, due to steam on all parts in a double-acting engine, but in a single-acting engine we have always the pressure on the crankpin on the up-stroke, this being a constant quantity. It must, therefore, be admitted, from theoretical considerations alone, that the single-acting engine cannot be as efficient as the double-acting one, and from the results of actual tests the author has in his possession, this appears to be so in practice. This is only what could be expected, as it cannot be possible to lubricate a single-acting engine more efficiently than a double-acting one; in fact, on the face of it, it does not seem possible to lubricate it as well, the bearings always being under pressure in one direction. It has been proved over and over again that it is possible to make an engine of the double-acting type to work silently at speeds equal to any single-acting engine now running; and, if so, what, then, is the advantage in the way of speed that the single-acting type of engine has over the double-acting type?

Durability.—The most prevalent idea respecting quick revolution engines is that, owing to the number of revolutions, and the consequent changes in the direction of pressures on the parts, in the double-acting engine, all working joints must wear very rapidly, and very much more so than in slow-revolution engines. This undoubtedly would be the case in a double-acting engine, were it not for the excellent means of lubrication that are provided. In an engine of this type all the pins, journals, and slides are made of ample area, so that the pressure per square inch may be reduced to such a figure as has been found most suitable in practice. To illustrate this point, we will take an ordinary marine type compound engine as an example. In ordinary practice the maximum pressure per square inch on the crosshead pin is about 1,500 lbs., the pressure per square inch on the slides about 60 to 70 lbs., on the crank-pins, 500 to 600 lbs. per square inch on the journals, 400 lbs. per square inch; whereas, in a modern double-acting quick revolution engine, these pressures do not, on the average, exceed the following:—

Crosshead pins		1,000 lbs.	per square inch.
Slides ...	...	40	" "
Crank-pin	...	400	" "
Journals	...	250	" "

and all the above-mentioned joints, &c., in a double-acting engine are supplied with oil under pressure from a special pump, driven in most cases from one of the eccentrics driving the valves. By this means every working surface is kept flooded with oil, and whenever the pressure is relieved from off that surface—or, say, between the pin and the bearing, the oil is there, under pressure, ready to spread itself between the surfaces, so that, when working, the shaft or pins never come in direct contact with their respective bearings, always being separated by a film of oil.

Owing to this necessity for ample lubrication, it has been found necessary to enclose all the working parts of a quick revolution engine in a suitable cast-iron frame, or its equivalent. This prevents the oil being thrown about while the engine is working; but another great advantage is that it prevents any dirt or grit getting into the working parts and so causing heating of the bearings. An objection has been raised to this closing-in of the engines, as it is thought that the parts are thus made inaccessible, but the experience gained by the leading builders of quick revolution engines has enabled them to design engines, in which, while having the working parts entirely enclosed, by removing one or two doors in the frame everything is made perfectly accessible, and any part can be removed without any difficulty whatever.

(To be continued.)

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS, 1901.

Compiled expressly for this journal by W. P. THOMPSON & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, Manchester, and Birmingham, to whom all inquiries should be addressed.

26,087. "An improved rebate system for the sale of electric energy. G. MARINIER. December 21st.

26,098. "Improvements in apparatus for controlling electric motors." J. H. HINDLE. December 21st.

26,112. "Improvements in primary electric cells or batteries." S. G. WIDER December 21st.

26,119. "A fuse carrier with spring action, for use on distribution boards used for electric lighting and power purposes." G. TURNOCK. December 21st.

26,131. "Improvemente in electric insulators for high potential lines." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (C. E. Barry, United States.) December 21st. (Complete.)

26,132. "Improvements in electric circuit breakers." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (E. M. Hewlett and C. E. Badeau, United States.) December 21st. (Complete.)

26,133. "Improvements in glowers for pyro-electric lamps and process of making the same." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (C. P. Steinmetz, United States.) December 21st. (Complete.)

26,134. "Improvements in means for transmitting synchronous motion to distant points." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (L. Saxon, United States.) December 21st. (Complete.)

26,135. "Improvements in means for starting alternating current dynamo-electric machines." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (J. E. Woodbridge, United States.) December 21st. (Complete.)

26,136. "Improvements in ground detectors for electric circuits." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (C. C. Badeau, United States. December 21st. (Complete.)

26,137. "Improvements in electric railways." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (W. B. Potter, United States.) December 21st. (Complete.)

26,138. "Improvements in electric railways." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (W. B. Potter, United States.) December 21st. (Complete.)

26,139. "Improvements in electrolytic arc lights." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (W. T. Dean, United States.) December 21st. (Complete.)

26,159. "A new or improved electric trumpet." E. R. DALE. December 21st.

26,161. "Improvements in hoods for use in connection with telephones." E. W. SMITH. December 21st.

26,197. "Improvements in electric arc lamps." E. BATAULT. December 23rd.

26,203. "Improvements in horse-shoe electro-magnets." P. SCHNEIDER. December 23rd. (Complete.)

26,227. "Improvements relating to electro-magnetic switches, and to methods of controlling or operating the same." H. H. LAKE. (McElroy-Grunow Electric Railway System, United States.) December 23rd. (Complete.)

26,241. "Improvements in apparatus for signalling between ships, shore and other objects by means of electric or Hertzian waves." G. HUGHES. (M. A. Moray, Trinidad.) December 23rd.

26,251. "Improved means and appliance for starting electric lamps of the 'Nernst' kind." E. CERVENKA. December 23rd. (Complete.)

26,307. "Improvements in connection with message counters for telephone exchanges." H. OPPENHEIMER. (Actiengesellschaft Mix & Genest, Germany.) December 24th.

26,316. "Improvements in means for regulating electrical oscillations." J. A. FLEMING. December 24th.

26,328. "Means of performing electro-chemical reactions." R. PEARSON and O. MARCH. December 24th.

26,341. "Improvements in multiple conductors for electrical distribution." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (A. D. Lunt, United States.) December 24th. (Complete.)

26,342. "Improvements in electric arc lamps." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (E. Thomson, United States.) December 24th. (Complete.)

26,343. "Improvements in electric arc lamps." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (A. G. Davis, United States.) December 24th. (Complete.)

26,344. "Improvements in insulated electric conductors." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (W. Le Roy Emmet and W. S. Clark, United States.) December 24th. (Complete.)

26,345. "Improvements in means for transmitting electrical energy." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (J. E. Woodbridge, United States.) December 24th. (Complete.)

26,346. "Improvements in controllers for electric automobile vehicles." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (H. Lemp, United States.) December 24th. (Complete.)

26,347. "Improvements in systems of electric generation and distribution." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (E. M. Hewlett, United States.) December 24th. (Complete.)

26,348. "Improvements in starting alternating electric current machines." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (J. E. Woodbridge, United States.) December 24th. (Complete.)

26,349. "Improvements in electric transmission of power." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (E. M. Hewlett, United States.) December 24th. (Complete.)

26,358. "Improvements in or relating to circuit breakers for electric current-circuits." E. F. MOY, P. H. BASTIE, and E. F. MOY, LIMITED. December 24th.

26,363. "An improved insulating material and process of manufacture of same." V. KARAVODINE. December 24th.

26,369. "Method of and means for transmitting power from electro-magnetic devices to movable bodies." R. T. GLASCODINE and H. H. KENSHOLE. December 24th.

26,373. "Improvements in microphones or microphone transmitters for electrical sound transmission." F. W. SENBEIL. December 24th. (Complete.)

26,377. "Improvements in induction electric meters." O. T. BLATHY. December 24th. (Complete).

26,387. "A new or improved maximum demand indicator for electric currents." W. G. HIBBINS. December 24th

26,393. "Improvements in telephonic transmission, and in apparatus there for." D. H. STURMAN. December 24th.

26,420. "Improvements in the method of and means for ascertaining and recording the consumption of current in electrical traction." C. H. BERRY and W. T. HILL. December 27th.

26,474. "Improvements in electrical valve apparatus for actuating the air brakes of railway trains." C. D. ABEL. (Siemens & Halske Aktien Gesellschaft, Germany.) December 27th.

26,475. "Improvements in maximum demand indicators for measuring and recording electrical currents." W. R. RIDINGS and VERITYS, LIMITED. December 27th.

26,476. "An improved electric switch." S. B. MARSHALL." December 27th.

26,482. "Improvements in electric telegraphy." A. B. TUBINI. December 27th.

26,488. "Improvements in electric demand indicators." H. G. LORRAIN. (H. A. Macdonald, France.) December 27th.

26,487. "Carbide electrodes for arc lamps and process of manufacturing the same." R. HOFFELT. December 27th.

26,510. "An improved 'resistance ball,' applicable to overhead tramway wires." J. A. PENNY. December 28th.

26,510. "Improvements relating to the laying of underground electric conductors for lighting and power." W. P. THOMPSON. (F. Davis, Belgium.) December 28th. (Complete.)

26,553. "Improvements in cable drum wagons." S. RAWLINSON, W. RAWLINSON and J. RAWLINSON. December 30th.

26,566. "Party line telephone system." F. E. MAYBERRY. December 30th. (Complete.)

26,604. "Improvements in instruments for recording varying magnetic fields or the currents producing them." SIEMENS BROS. & CO., LIMITED. (Siemens and Halske, Aktien Gesellschaft, Germany.) December 30th. (Complete.)

26,626. "Improvements in electric telegraphy." A. B. TUBINI. December 30th.

26,634. "Means for connecting an alarm bell in a local system to the telephone exchange." P. RABBIDGE. December 30th.

26,646. "Improved method of, and means for lubricating the axles or bearings of tramcars and wagons used on electric tramways and light railways." E. J. SANER. December 31st.

26,658. "Improvements in apparatus for hermetically enclosing and insulating the junctions of conductors for electric currents and other purposes." V. BORNAND and F. C. LYNDE. December 31st.

26,659. "Improvements in electric light brackets or pendants." R. WALLWORK and C. H. WALLWORK. December 31st.

26,673. "Improvements in apparatus for the generation and electrolytic application of electric currents." F. E. ELMORE. December 31st.

26,690. "Improvements in electric arc lamps." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (E. Thomson, United States.) December 31st. (Complete.)

26,691. "Improvements in electric circuit controllers." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (E. M. Hewlett, United States.) December 31st. (Complete.)

26,692. "Improvements in electric current limiting devices." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (S. L. G. Knox, United States.) December 31st. (Complete.)

26,693. "Improvements in electric circuit breakers." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (R. H. Read, United States.) December 31st. (Complete.)

26,694. "Improvements in electric circuit breakers." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (R. H. Read, United States.) December 31st. (Complete.)

26,695. "Improvements in dynamo-electric machines." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (H. Geisenhoner, United States.) December 31st. (Complete.)

26,696. "Improvements in electric rheostats." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (J. L. Hall, United States.) December 31st. (Complete.)

26,697. "Improvements in electric rheostats." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (W. C. Yates, United States.) December 31st. (Complete.)

26,698. "Improvements in systems of electric distribution." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (C. P. Steinmetz, United States.) December 31st. (Complete.)

26,699. "Improvements in the manufacture of filaments for incandescing electric lamps." W. L. VOELKER. December 31st.

26,700. "Improvements relating to the electric lighting of railway trains and to apparatus therefor." D. C. HENRY. December 31st. (Complete.)

26,702. "Improvements in controlling devices for connecting storage batteries with a charging circuit." J. W. STOVER and N. H. SUREN. December 31st. (Complete.)

26,721. "Improvements in material and devices for electric insulation, and the formation and protection of electric distributing systems, cables and the like." W. W. PILKINGTON and W. R. ORMANDY. December 31st.

26,743. "Improvements in electric arc lamps." J. H. HALLBERG. December 31st. (Complete.)

26,746. "A new or improved process or method of manufacturing electric or other lamp globes." E. BOHM. December 31st.

26,748. "A safety indicating apparatus for electric line-wire circuits." SIEMENS BROS. & Co., LIMITED. (Siemens & Halske, Aktien-Gesellschaft, Germany.) December 31st. (Complete)

26,749. "Improvements in safety fuses." SIEMENS BROS. & Co., LIMITED. (Siemens & Halske, Aktien-Gesellschaft, Germany.) December 31st. (Complete.)

26,759. "Improvements in or relating to means for supplying current to electric vehicles." W. L. WISE. (Maschinenfabrik, Oerliken, Switzerland.) December 31st.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson and Co., 322, High Holborn, W.C., and at Liverpool, Manchester and Birmingham, price, post free, 9d. (in stamps).

1900.

2,710. "Improvements in electricity meters." W. M. Mordey and G. C. Fricker. Dated February 10th, 1900. Clockwork geared to a counter is driven by a spring or weight, and has an escapement controlled electro-magnetically only, so that it stops in an extreme position when no current is passing, but otherwise is returned to a middle position by the action of the current to be measured, its momentum continuing the movement; the escapement and clockwork thus move at a rate proportional to the current passing. The escapement may consist of an ordinary escape-wheel and an anchor having a forked arm, which engages an eccentric pin on a shaft, carrying an armature. This may be a non-conducting disc carrying several parallel soft wires. It oscillates within stationary coils carrying the current to be measured or a proportion thereof, placed so that they tend to set the armature wires axially, as shown, and the anchor in its middle position. The conditions of proper working and suitable dimensions are specified. The armature may otherwise be a small bundle of wires, or a thin strip of iron, situated between stationary iron poles, which either extend inwards from the ends of an open rectangular core, or are the middle limbs of two separate **E**-shaped cores. An open winding surrounds the armature and the pole-pieces or the outer limbs of the **E** cores, to obtain proportional readings. The outer limbs of the **E** cores repel the armature from this extreme position. To prevent the armature from being stopped in its middle position if the current increases while it is moving slowly, the armature may carry a small weight tending to move it to either side. Or the main current coil may be short circuited while the armature is near its middle position, by providing the armature shaft with a flat surface to drop an anti-friction wheel and a switch lever at that time, making contact with a contact screw. In a modification, this contact connects a solenoid in parallel with the main current coil, the solenoid then moving a core and spring switch to short circuit itself and the main coil. The clockwork may be provided with automatic winding apparatus.

2,767. "Improvements in long-distance relay magnetic telephones." J. Nesset and J. F. Gouin. Dated February 12th, 1900. Magneto-telephones for use as relays are formed with magnets carrying coils set on either side of single or double diaphragms. The whole of the parts are enclosed in a hermetically-closed casing of non-magnetic material which is in turn enclosed in a four part protective surface. The strands of the cable are separated and clamped over the outer surface. The telephone diaphragms may be of magnetic or other material, in some cases a semi-circular permanent magnet being supported over the outer face of the diaphragm.

2,783. "Improvements in electrical arc furnaces." J. Y. Johnson. (Communicated.) Dated February 12th, 1900. An arc furnace of large size is provided with a number of separate upper electrodes of limited size independently adjustable, and situated at such distances apart that a uniform temperature is maintained over the whole area of the furnace. The furnace is worked discontinuously, each charge being drawn separately. The main object is to avoid losses due to the absence of fresh material and the production of excessive temperatures near the middle parts of large electrodes. The invention is distinguished from those described in Specifications Nos. 27,301, A.D. 1896, and No. 4,138, A.D. 1897, in that the materials do not pass all the electrodes successively and travelling arcs are not employed. The invention is applicable to furnaces for making calcium carbide and smelting.

2,797. "Improvements in coherers in telephonic and telegraphic signalling." A. S. Popov. Dated February 12th, 1900. In telegraph or telephone signalling by Hertzian radiation, the coherer is arranged with two metal plates secured in a glass tube and containing between them metal or carbon granules—preferably crushed up small steel balls. The spaces between the plates may be divided into compartments. Telephones may be arranged in the local circuit with or without an induction coil.

2,842. "Improvements in and relating to thermostatic controlling apparatus." A. G. Brookes. (Communicated.) Dated February 13th, 1900. Relates to an appliance for changing electrical connections when the temperature rises above a limit.

2,862. "Improvements in electric traction motors." C. Richter and R. T. Eschler. Dated February 13th, 1900. An electric traction motor is combined with the wheel of the vehicle. Upon the axle is mounted a hollow wheel composed of two sections united together by bolts and nuts, so that access can readily be obtained to the interior. The armature and commutator are carried by one of the sections while the field magnet is secured to the axle. The brushes are mounted in recesses formed in the field-magnet core; to permit of ready access to them, openings are formed in the other section, and provided with covers. Current is supplied to the motor by conductors running through the hollow axle.

2,880. "Improved system of and means for regulating electric motors and the like." W. H. Cooley. Dated February 13th, 1900. Relates to the regulation of the speed and torque of electromotors used on electrically-propelled vehicles and for other purposes, by connecting across the main feeders an electromotive force opposing or absorbing medium of practically constant value, with the different parts thereof in series with the motors to be regulated, and by varying the air-gap density, and by varying the driving connections of the motors.